SCIENCE PHILOSOPHY INTERFACE

Vol. I July - December 1996 No. 2

Calcutta Centre For Advanced Study
In Science And Philosophy
Calcutta

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CONTENTS

ARTICLE

Science and Spirituality : Convergence and Divergence 2

RAJA RAMANNA
National Institute of Advanced Studies
Indian Institute of Science Campus, Bangalore- 560012

On Comprehension of the Universe : from Spinoza to Einstein 15

MENDEL SACHS
Department of Physics
State University of New York at Buffalo, USA

Cosmology and Philosophy : the Ancient Indian Panorama 27

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92, Acharya Prafulla Chandra Road, Calcutta- 700 009, India
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Creation of Matter : Traditional Indian Thinking and Modern Science 33

ARPITA CHATTOPADHYAY
C/o CCASSP P.O. Box No. - 17012, Calcutta- 700 032, India
P. K. MUKHOPADHYAY
Department of Philosophy
Jadavpur University, Calcutta- 700 032, India

REVIEW

Astronomy in India : A perspective 78

S. S. DE
Department of Applied Mathematics, Calcutta University
92, Acharya Prafulla Chandra Road, Calcutta- 700 009, India

From Inter- disciplinary to Cross-cultural Studies 80

P. K. MUKHOPADYAY
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Jadavpur University, Calcutta - 700 032, India

DISCUSSION & OPINION

Model Theory & Hindu Philosophy 85

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Financial assistance for the publication of the first two issues of this journal has been received from S.N.Bose National Centre For Basic Sciences, Calcutta.

Science Philosophy Interface is a bi-annual journal of the Calcutta Centre for Advanced Study in Science and Philosophy (CCASSP). Original articles in English dealing with foundational problems of an interdisciplinary character or belonging exclusively to some area of science or philosophy will be published after obtaining approval of the referee and /or Editorial Advisory Board.

Articles for publication and books for review may be sent to any one of the editors. Two copies of type written articles and two copies of published books be sent.

All subscription and relevant inquiries be sent to professor Pratul Bandyopadhyay.

Copies of each issue of the journal will be sent to subscribers by ordinary mail for which no extra amount will be normally charged. Subscribers will be charged air mail cost if they want to get the copies of the journal by air mail.

Annual subscription rate (For two issues)

INLAND

Individual	Rs. 200.00
Institution	Rs. 300.00

FOREIGN

Individual	$ 100
Institution	$ 150

Individual issues can be obtained by paying Rs. 125 or $ 75

A BRIDGE BETWEEN SCIENCE AND PHILOSOPHY*

P. Budinich

It is for me an honor to be here in Calcutta to present the first beautiful number of a new journal aimed at establishing a bridge between science and philosophy, but also a pleasure because we in Trieste were pushed by a similar desire when we created at the International School for Advanced Studies the Interdisciplinary Laboratory. We recognized that science of the last decades was more and more dealing with subjects traditionally dealt with by philosophy and for some new opening branches, like cognitive sciences, the contribution of epistemologists was crucial. There was then a common need, felt both in Trieste and Calcutta, and it is then natural to conclude that we should keep in contact, communicate, inform each other and join our forces for better reaching our common goals.

But there could be something more to expect from our working together. Science is one of the many good fruits of our civilization, and these fruits naturally bear the features of the cultural ground from which they arise. Therefore it is important and interesting to explore the roots of our scientific knowledge.

As an example next December we will try to organize in Venice a Symposium on the poetic-philosophical intuitions of presocratic philosophy to be compared with the scientific discoveries of our century.

Now your India's cultural background arises from one of the oldest and most profound human philosophy not very well known to us, or whatever is known often arrived to us through biasing filters. Therefore a good service that only you could do to our common effort would be to lead us with your authority to the genuine cradle of your culture since from there we could have perhaps a new, illuminating perspective of the conception of the world which science is presenting us, specially the one of the last decades.

Therefore I hope and wish that this occasion might be also a first step of a future profitable and enjoyable common work.

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* *We are greatful to Professor Budinich for sending us this summary of his speech delivered when he released the first issue of this journal. — Eds.*

SCIENCE PHILOSOPHY INTERFACE
VOL. 1 JULY-DECEMBER, 1996 NO. 2

SCIENCE AND SPIRITUALITY
Convergence and Divergence

Raja Ramanna

The title of this address is not mine, but one suggested for a paper which was prepared for a seminar on this subject, held in honour of the Dalai Lama during the celebration of his 60th birthday. The title expresses the concern of many people of the contradictions in daily life especially with their inner thoughts and conflicts with the laws of the external world as we know them. Besides, while most people understand by what is meant by 'religion', the term 'spirituality' has many meanings and thus many connotations. One can be a very good scientist and still be a man of great spiritual strength, but I am not sure that any scientist worth his name will agree with all that religion has to teach him. Even Mahatma Gandhi who was one of the most spiritualised persons the world has seen, said, 'All religions have some things which are both true and false.'

Many thinkers, particularly scientists, have at different times, questioned the very need for religion and at the end of the Second World war, the general feeling was that all the problems of the world could be solved by science and technology. This of course has not happened essentially because the behaviour of the human brain (See appendix-1), singly or collectively, has not been understood by the methods of science.

Of all the religions of the world early Buddhism comes closest to a rational analysis of scientific knowledge and human understanding which make a discussion on convergence and divergence truly meaningful. But before we accept the stand taken up by Buddhism, we briefly consider other interpretations which are still attractive to a very large number of people.

The first is the existence of God. While nobody can prove his existence in any scientific sense, yet to many people he is the almighty anthropomorphic father, compassionate, strict but just. This picture of God is essentially derived from the background of the Mediterranean religions and perhaps tribal thoughts. In Vedantic

religion, God is a divine power having many manifestations but is essentially an abstract entity — the Brahaman who is within all living matter. Shankara's logic which is the clearest exposition of Advaita Vedanta cannot be wished away, as he was the sharpest mind of his age. He had to refute Buddhist logic, introduce Divinity back into Indian thought, which the Hindu can never really give up, and finally to give the Soul a special position of eternity, that it is always there and gives everybody, come what may, the hope of an eternal existence. In this process Shankara uplifted the position of Brahman to that of Absolute Reality and the world to the status of a projection through Maya. . While the theory is beautiful, the reduction of all else to the position of only a projection whose reality is not prime, does not go well with physical reality as we know. However, his teachings do not in any way make it invalid. It allows for a deeper meaning, possibly connected with the existence of a subjective reality, a field of knowledge that is a matter of great interest to all scientists in recent times. The starting of a new international journal on 'Consciousness' involving many distinguished scientists can be taken as a measure of this new interest.

The many non-Vedic religions of India deny the existence of a God and early Buddhism gave more importance to a proper life and causality than to any Divinity. We will speak of these matters later, but before I do that, I must make a mention of a system which has influenced millions of people and that is Puranic Hinduism. It has a unique structure in that one can worship what he likes 'ISHTADEVATA', from among the various puranic gods and the puranic gods like the Greek gods of the past mingle with the ordinary folk and make life pleasant though sometimes ridiculous, especially when godmen are involved. This system allows for the absorption of various tribal religions and in that sense integrates society. As can be expected 'rituals' play an important part and, in spite of its psychological advantages, can hardly be justified on any scientific grounds.

On matters of Hell, the problem is simpler, provided we restrict ourselves to Dante — the great prerenaissance poet, who describes how the entrance to Hell is inscribed with the words "Hope Abandoned", a beautiful description indeed. We can find many places even on our Earth where such a sign would be appropriate. However, the Last Judgement and other horrors of Hell we can safely leave out of consideration. The theory of Reincarnation and the existence of an eternal soul holds a powerful position in almost all religions and no doubt gives much consolation to the believers. That all this does not satisfy the hopes of the learned is best described in an incident in the Mahābhāratha : After the great war the Pandavas find themselves in a state of great depression and Arjuna longs to see his dead son, the noble, brave Abhimanyu. He still hopes to see him in heaven or wherever he has to go after death

—so depressed he is. But the savants tell him 'Yes, Arjuna, you will see your beloved son Abhimanyu in heaven, but he will not recognise you !"

We now take a closer look at Buddhism. On matters concerning heaven, hell, reincarnation and soul, early Buddhism dispensed with all of them and death was merely treated as an absorption into Nirvaṇa. How people accepted such sweeping and revolutionary changes at that remote period of time lasting for a period of nearly 600 years seems amazing. It was the failure of the Sangha that brought Buddhism its decline and disappearance from the land of its birth. I believe that the world was not just ready for him.

We summarise the above thoughts by means of set diagrams in Appendix A, which have the power to describe these complex thoughts in a concise way.

The Buddhist religion brought with it during its early period a powerful school of logicians. Of the many celebrated names we will concentrate on the work of Nāgārjuna (~ 6th century A.D.). Though some European scholars have questioned his very existence, there is ample proof that he lived in the Andhra Country and though many of his works in Sanskrit are lost, some are available in Tibetian, and recently a Sanskrit work has been found in a Tibetian monastry, preserved as they all are in the well organised monasteries in various parts of Tibet.

We can summarise the conclusions of Nāgārjuna in the following way : It is called the theory of 'Nothingness' and with it is a treatise on the ineffectiveness of logic. The Sunyata theory, as it is called, has been compared to the modern theory of vacuum stated in particle physics and coincides with the statement that vacuum is the creative element of all things. The universe has its beginning in nothingness and everything is of nothingness. To make this a little clearer I cannot help from quoting from K.Bhattacharya's introduction to his celebrated translation of recently found original Sanskrit version of Nāgārjuna treatise *VIGRAHAVYAVARTANI*. "Though only a 'minor work' in form, as regards its contents, the *Vigrahavyavartani* is a fundamental text of Mādhyamaka, as well as of the early Indian dialectical (vada) tradition. Not only does it admirably illustrate the dialectical method followed by Nāgārjuna, the founder of the school, but it also clarifies the idea of voidness (śunyatā) which has been so often misunderstood, not only in modern times and abroad, but in India itself, and in Nāgārjuna's own time. 'You have not understood the meaning of the voidness of the things', says Nāgārjuna to his opponent — a Naiyayika commentary.

Written after Nāgārjuna's major work, the Mulamādhyamakakārikās (From which it quotes a verse), the *Vigrahavyavartani* is undoubtedly 'one of his best works and

shows him in all that is peculiar to him, above all in his unperturbed consistency', as E. Frauwallner observed.

In refuting the logician's criticisms, Nāgārjuna does not disdain form logic. Why are all things 'void' (sunya) or 'devoid of an intrinsic nature' (nihsvabhāvah) ? Nāgārjuna's 'reason' (hetu) is that all things are 'dependently originated' (pratityasamutpanna). But the best way for him to refute his opponent's criticisms is to show the inner contradiction of the latter's thought and to use against him his own logic. And that, I think, he does admirably well. We find here, especially, a brilliant criticism of the pramānas 'means of true cognition' of the Nyaya system, which occupies in this work the central position, and which is also the first one that has come down to us.

The logician's objections against what appears to be a negation in the doctrine of voidness, are faithfully reproduced by Nāgārjuna in the *Vigrahavyavartani*. If, as Nāgārjuna says, 'all things are devoid of an intrinsic nature' (nihsvabhāvah sarvabhāvah) or 'the things have no intrinisic nature' (nāsti svabhāvo bhāvanam) or 'all things are void' (sunyah sarvabhāvah), this enunciation must be equally 'devoid of an intrinisic nature' (nihsvabhāva) or 'void' (śunya). But then, how can a void statement deny the other void things? If this negation is valid, the enunciation itself is not void. But, in this case, all things are not void, since the enunciation, which is included in 'all things', is not void. On the other hand, according to the logicians, a negation is significant only when the object to be negated is a real entity, not when it is a fictitious one. In the circumstances, if the negation of the 'intrinsic nature' (Svabhāva) of the things, in Nāgārjuna's philosophy has a meaning, it only proves that very 'intrinsic nature' which is negated !

Nāgārjuna admits the cogency of these arguments. In the Mulamadhyamakakārikās he even bases his own argumentation often on the logicians' principle, namely, that a negation is not possible if the object to be negated is not real. Candrakirti, his great commentator, makes it explicit in his commentary, the Prasannapaādā. Only Nāgārjuna does not negate anything, for there is nothing to be negated : all things being void, there is neither a thing to be negated nor a negation. The function of the statement 'All things are devoid of an intrinsic nature' or 'the things have no intrinsic nature', says he, is to 'make known the absence of an intrinsic nature in all things', because they are naturally 'void of an intrinsic nature' (svabhāvaśunya), being 'dependently originated' (pratityasamutpanna). Negation of the 'intrinsic nature', with Nāgārjuna, is thus designed for dissipating the error of people who see an 'intrinsic nature' in the things while they have none. In other words, it has merely a therapeutic value — as Candrakirti makes it clear in his comment on Mulamadhyamakakārikā.

Nāgārjuna strives to express the Inexpressible. All his expressions, therefore, are bound to remain inadequate. 'All things are void (or devoid of an intrinsic nature)' is not a "proposition" which denies or affirms something. By 'making known' the 'voidness' of all things, it only expresses, indirectly, the Absolute, which is 'perfectly appeased' and 'isolated' from all its appearances.

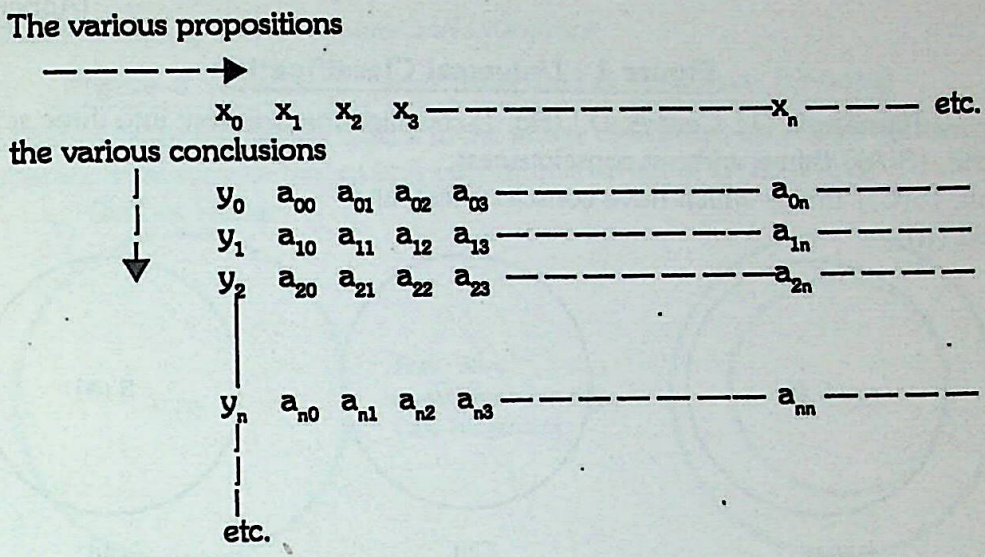
Nāgārjuna seems to be a mystic. But he is not a mystic who renounces thought and its expression in language. Along with all mystical philosophers, he knows that 'the ultimate in thinking as the ultimate in communication is silence'. Like them, too, he uses thought in order to transcend it. It is only when by his inexorable logic he has been able to bring to light all the contradictions inherent in our relational way of thought, that he experiences Being or Nirvaṇa, which is beyond all relations, in a shipwreck so to say.

Nāgārjuna's Absolute is neither the world not apart from the world. It is the 'intrinsic nature' of the world. But to say 'It is the intrinsic nature of the world', is to make of it an object, standing in relation, on one hand, to the thinking subject, and on the other, to other objects, and thus to deprive it of its all-encompassing character. The only way in which Nāgārjuna can speak of it (or, rather, out of it) is to say : 'All things in the world are devoid of an intrinsic nature', i.e., the things in the world are not as they appear to us.

Here Nāgārjuna had to face the objection : If all things are void, how can our activities in the world become possible? Even the religious discipline taught by the Buddha becomes meaningless. But this objection, Nāgārjuna replies, springs from a fundamental misunderstanding of 'voidness', i.e., 'dependent origination'. All our activities, religious or not, are possible only in this relational world of becoming. If 'voidness', i.e., becoming, is denied, then the world itself is assumed to be the Absolute, 'not born, not destroyed, immutable, free from the manifold states (of its becoming)', 'There is nothing to be done, no work is undertaken, the agent does not do any work.'

Thus, Nāgārjuna neither denies the world nor affirms it. His is a middle path. It is the world that he transcends the world and thus transfigures it. There is not the slightest difference between Saṃsāra and Nirvana. The difference between them is in our way of thinking. Nirvaṇa is Saṃsāra without appearance and disappearance, without dependent origination.

The great logician, surprisingly enough, thus questions the very validity of the logic using logic. One of the ways of seeing this is to consider the following matrix :


The various propositions
x_0 x_1 x_2 x_3 x_n etc.
the various conclusions
y_0 a_{00} a_{01} a_{02} a_{03} a_{0n}
y_1 a_{10} a_{11} a_{12} a_{13} a_{1n}
y_2 a_{20} a_{21} a_{22} a_{23} a_{2n}
y_n a_{n0} a_{n1} a_{n2} a_{n3} a_{nn}
etc.

Here the x's are a series, perhaps infinite in number, of propositions from which we select some of them to demonstrate one of the conclusions among the y's. For example , if we have to prove some thing about eclipses some of the x's could be statements like, "the moon is seen in the night" or "the sun outshines it during the day", etc. We may require these to prove some statement on eclipses the y's, but we will not require all the x's. Those we require we will give the a's the value of 1 and those we do not require the value 0.

Thus to show logically some y is true it is equivalent to some binary no like 100010101110 etc.

Take an argument which uses all the diagonal elements to prove a certain y's, such as the one given above : 100010101110 etc. Now take the statement where the 1's are made into 0's and vice versa, which becomes the conclusion 011101010001. This statement will never be found in the enumeration, and remains so whatever rearrangement you do. Hence, we show for every exhaustive matrix of the type described above, there will always be many conclusions which cannot be logically demonstrated.

* * *

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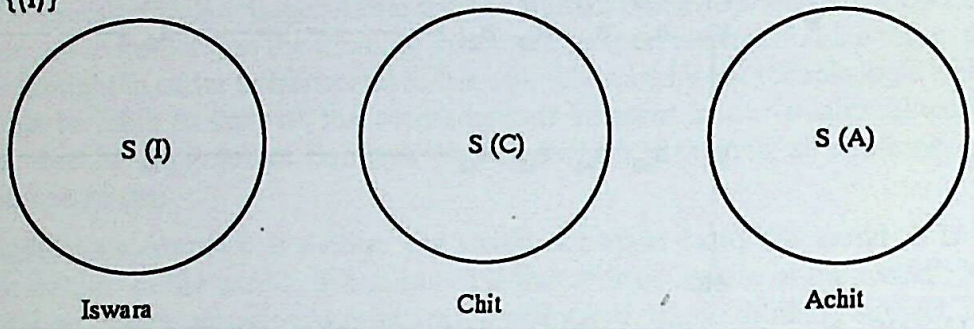
2. Swami Ramakrishnananda, *Life of Sri Rāmānuja* (Translated from Bengali by Swami Budhānanda), Sri Ramakrishna Math, Madras, 1977.

(Appendix A)

Figure 1 : Universal Classification

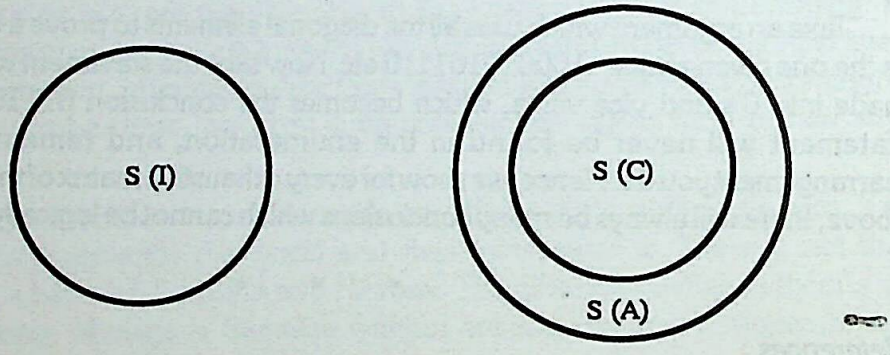
Rāmānuja (11 Cent A. D.) (Fig. 1) classified the universe into three sets.
Achit, {S(A)} things without consciousness,
Chit, {S(C)} things which have consciousness, and
God {(I)}



It is the interaction between these components that constitutes religion in a general sense.

Figure 2 : Mechanistic and Chārvāka (Pre Buddhist)

In Mechanistic and Chārvāka Philosophy S(I) does not exist and S(C) is embedded in S(A) Fig (2)

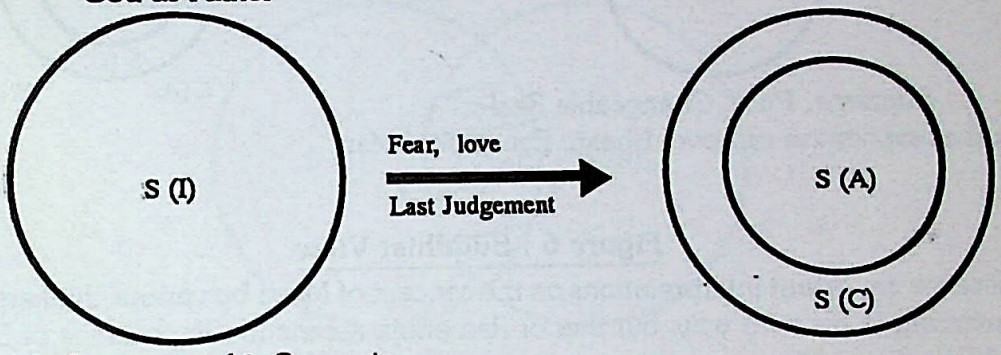


S(I) is a null set
Evolution : Natural Selection
Survival of Fittest

Figure 3 : Mediterranean Religions & Mādhava (Dvaita)

In the Mediterranean religions God is in the image of a father, i.e., anthropomorphic but separate from human beings and evolution is an act of God. (Fig 3).

God as Father

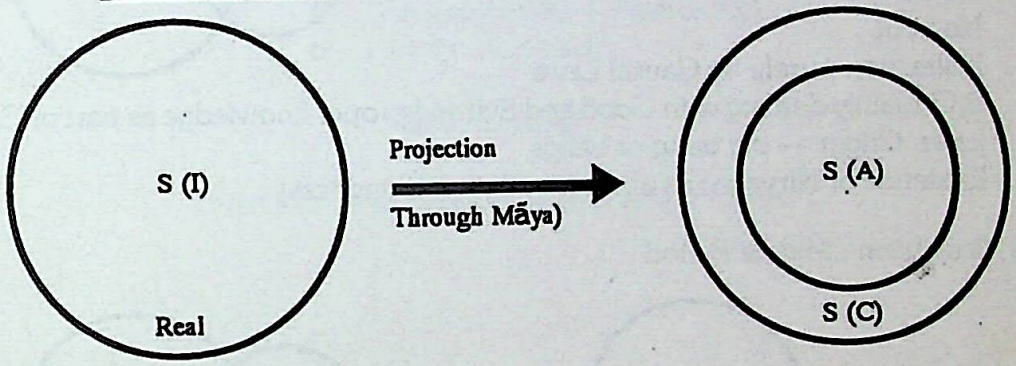


Anthropomorphic Separate

Evolution : Act of God

Social Forces, Fear, Inherent Love of Humanity

Figure 4 : Vedantic (Advita) (Shankara 8th Century)



Supreme, Symmetric, Pure, Unchangeable

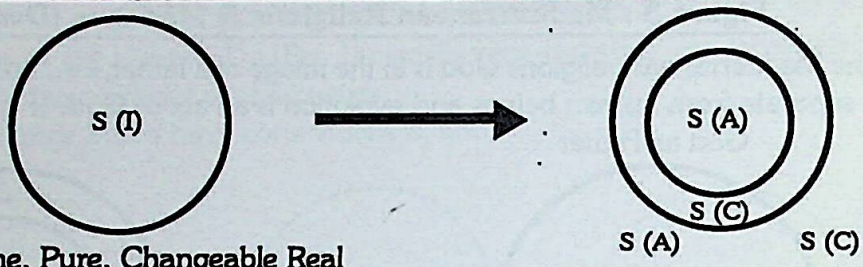
Projection of Brahman through Maya
(Due to Unchangeability of Supreme Brahman)

In the Vedānta and in the logic of Śankara, S(I) is abstract, unchangeable, pure and is the only reality, all else is a projection of the Brahman within and around us and the projection is through Māya, a word derived from matra meaning immeasurable.

Evolution : Symmetry of Summetry (*Chāndyoga Upaniṣhad*)

"... though some held that chaos alone was before a second, and order came of it, how can it ever be so. Order indeed was alone in the beginning ...

Figure 5 :Visista-Advita (Ramanuja 11th Century)



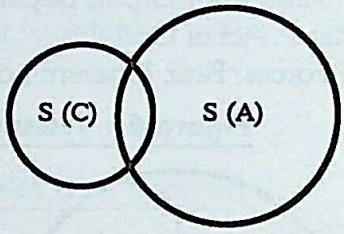
Supreme, Pure, Changeable Real
God as expression of Love, Bhakti, Equality of Man

* * *

Figure 6 : Buddhist View

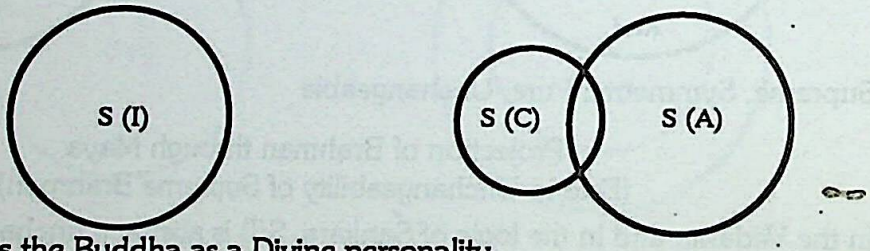
There are important interpretations on the concept of Maya by various thinkers each convincing in his own way, but that of Ramanuja asserts the importance of Bhakti and Equality of Man.

(A) Early Buddhism



1. No God
2. No Soul
3. Interaction purely by Causal Laws
4. S(C) mainly dealing with Good and Evil and proper knowledge as part of Causal Laws. Origin — big bang or bangs
5. Existence of Nirvaṇa (as absorption into nothingness)

(B) Buddhism : Middle Period

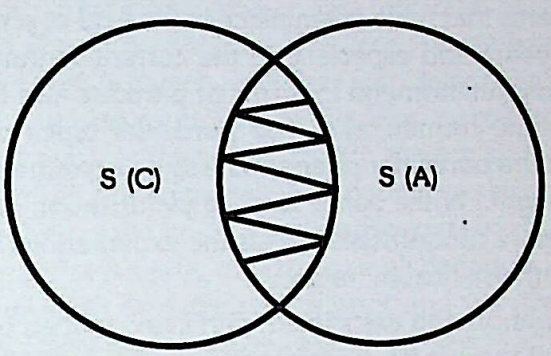


S(I) now represents the Buddha as a Divine personality
S(A), S(C) interaction dealing with individual salvation (Nirvaṇa) — close to the idea of Vedantic Brahaman

(C) Buddhism : Final Period

Theory of Śunyatā

Figure 7 : Quantum Mechanics



Interaction to allow for :

a) Collapse of wave function
b) Immeasurability (Uncertainty)
c) Holistic Approach

S(C) U S(A)

Evolution : Molecular and Symmetry Process

* * * *

APPENDIX - 1

CONSCIOUSNESS AND SCIENTIFIC EXPLANATION

(B. V. SREEKANTAN)

The developments that have taken place in the field of physical sciences over the past four hundred years and especially in the current century enable us to explain practically all physical phenomena in terms of particles and forces operating within appropriate space-time frameworks. The particular types of particles and forces involved depend on the particular phenomena to be explained and the level at which explanations are sought. While some kind of picturisation is possible upto certain levels, as we go to more fundamental levels the explanations become more abstract and esoteric and mathematical in nature.

In the case of phenomena associated with living matter, a feature that has been well established is that there is no evidence for any difference with ordinary matter in the basic constituents. Therefore, it is believed that in the ultimate analysis all processes associated with living matter, though distinctly different, should be explainable in terms of collective and emergent behaviour of the same constituents. Working out the details has no doubt been a tall order since the biochemistry that goes on within even a single cell under the control of the genetic code in the DNA molecule is more complicated than the chemistry that goes on in a sophisticated chemical factory producing the most exotic chemicals. In this perspective how does one find a scientific explanation for the phenomenon of consciousness which is unique to or is in the most advanced state in man and is behind all his activities — mental and physical ? Instead of getting lost in the maze of efforts to find an explanation that covers all aspects of consciousness, and deals with it in totality, in recent years the neuroscientists have been concentrating on delineating the neuronal correlates in the brain processes associated with specific and limited aspects of the phenomenon like — cognition, computation etc. Analogous to the role of particles under different forces in the case of physical phenomena, it is now recognised that all mental phenomena are essentially related to the 'firing' of different sets of neurons in the brain, the firing of a neuron being the generation and propagation of an action potential — an electrical pulse of amplitude about 70 millivolts and duration a few milliseconds. The generation of these potentials takes place in different locations of the body — in the sensors associated with eyes, ears, nose, skin and tongue, and in the special areas of the brain that have to give commands for specific actions and in the synapses. There are a few hundred billion neurons that connect different areas of the brain with the different regions of the body. The information that is brought into the sensors — visual, auditory, etc,. is

transformed into action potentials and are coded in a manner similar to frequency modulation in radio communication.

While the action potentials have the same amplitude and duration, the repetitive frequency, the burst like character, the time separation between bursts etc., reflect the details of the information to be transmitted. The information is also in the number of simultaneous firings of bundles of adjacent neurons, there being also feedback from one set of neurons to another. Each neuron has associated with it a thousand synapses on the average. The synapses control the forward propagation of the signals through the release of neurotransmitter chemicals. In fact, at each synapse the propagation of the signal is not electrical, but chemical. The neurotransmitter chemical released in the synapse decides whether the signal should propagate further or should be aborted. The action of the synapses is partly determined by genetical information and partly by the memories implanted during development and previous encounters. For the same purpose occasionally new synapses are also created along the neurons.

While considerable progress has been made in figuring out many of these details in neuronal firings, the one aspect that is posing the most serious problem is the 'binding problem'. The information even with regard to one aspect of a single event like, say, visual perception that is carried by the neurons is distributed in widely different parts of the visual cortex with no apparent interconnections between the parts. There is no evidence for a centralised location either in the brain where all the information comes together for what many be called a final processing and generation of any specific instructions to be carried to the relevant parts of the body by the motor neurons. There is no 'homunculus' or little man processing all information and giving instructions.

There have been in recent years, many approaches to this binding problem. Rapid 40 cycles per second oscillations on which neuronal signals ride have been recorded in the visual cortex of cats subjected to specific visual tasks. Crick and koch have suggested that such synchronised firings riding as a 40 Hz wave (could be in the range 35-70 Hz) might be the neural correlates of visual awareness.

Herbert Frohlich of Liverpool University had envisaged quite sometime back, that in biological tissues there could be the formation of molecular electric dipoles that vibrate in unision when sufficient bio-energy is 'pumped' in. Such vibrations could lead to the formation even at body temperature of coherent systems similar to the Bose-Einstein condensates that are formed at very low temperatures as in superconductivity, superfluidity etc. The central idea of the Bose-Einstein condensate (based on quantum mechanical coherence) is that a single state (a single wave function)

can replace all the participating states (the wave functions of the individual atomic systems). Frohlich had calculated that in the molecular dipole mechanism in the tissues, the vibrations generated would be in the microwave range (Giga Hertz). On the basis of formation of Frohlich Systems, Marshal came out with the idea that conscious phenomena (images, thoughts etc.) could be the excited states in such systems. Hameroff (1) has extended this idea further. He considers the cytoskeletal microtubules in the neurons to act as the substrate for the Bose-Einstein condensates and consciousness may be a "macroscopic quantum state" originating from a mixture of coherent states having their origin in the microtubules. Explanation of the binding problem in terms of quantum processes, it has to be emphasised, does make it more mathematical and abstruse. It, however, achieves scientific acceptability since non-locality and existence of superposed states, the very distinguishing hallmarks of quantum theory, have been tested out experimentally. Looking upon conscious states as macroscopic quantum states of the brain as a whole provides automatically for the unitary aspect of consciousness as well.

Hameroff points out further that the water molecules at the surface of membranes and cytoskeletal structures could be "ordered" and such organised dynamic water clusters could become pixels of information storage. On the paradigm of cellular automata, Hameroff has even worked out a model of information processing in the microtubules.

Formation of macroscopic quantum states arising out of internal neuronal mechanisms may become experimentally detectable as technology advances. Each macroscopic quantum state may reflect a particular sensation (quale). Hameroff points our that, for example, quale of redness may correspond to a particular macrostate — a specific frequency of the boson-condensed field excitation in the brain, (Of course different from the frequency corresponding to the red part of EM spectrum). If with future technology the detection of such frequencies become feasible, then it would be most crucial to verify whether the same frequency boson-field excitations take place in different individuals who are viewing the same object.

While perhaps one is a very long way yet to assert that a purely physical basis for consciousness is established or the prospects of it are near, what is most exciting is that these approaches are opening up new avenues of experimental exploration of brain processes demanding more advanced technological tools with high spacial and temporal resolutions.

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1. Stuart R. Hameroff, Journal of Consciousness Studies, 1, No.1, (1994) 91-118.

SCIENCE PHILOSOPHY INTERFACE
VOL. 1 JULY-DECEMBER, 1996 NO. 2

ON COMPREHENSION OF THE UNIVERSE
from Spinoza to Einstein*

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I

A very significant theme that has persisted throughout the history of science and philosophy, especially during its periods of accelerated progress, is a predominance of conflicts of ideas in regard to our comprehension of the universe. One of the outstanding conflicts, since the periods of ancient Greece and Asia, concerns the fundamental nature of matter, as to whether it is basically characterized by particularity — a sum of individuated parts — or whether it should be more accurately comprehended from the standpoint of continuity and holism, whereby the whole is indeed one, rather than a sum of parts.

In this essay, I will not compare these opposing points of view as much as concentrating on one of them — that of continuity and holism — an approach that may very well be that of the future, based on the presently evolving status of the foundations of physics, from the domain of cosmology to that of elementary particle physics.

I will discuss this general approach to knowledge of the material universe, as it was understood by Spinoza, then tracing this view through an aspect of Newton's physical outlook — particularly the role of his third law of motion, seen as an important precursor for Einstein's "closed system" field approach that evolved with general relativity theory, then to Faraday's field concept and finally to the present day version envisioned in Einstein's unified field approach to a comprehension of the substantial universe.

At the outset, I would like to define my use of the words, "cosmology" and "universe". The word "cosmology" is made up of the two Greek words, "cosmos" — meaning the entire material universe, and "logos" — meaning reason. Thus, "cosmology" is the science that seeks to explain the manifestations of the universe as

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* *This eassy is based on a paper that was given at the Israel Colloquium for the History, Philosophy and Sociology of Science Jerusalem, 1985.*

a whole, in terms of underlying principles. The word, "universe", in turn, is meant in the sense of the totality of all substance — all that there is — from the very smallest domain in physics, that of elementary particle physics, to the very largest — intergalactic distances and greater. My meaning of the word "universe" in the title of this essay then has to do with the domain of all that there is and the fundamental principles that underlie all of its manifestations. It will be assumed here that there is a basic oneness in regard to the fundamental principles that underlie all physical phenomena. This is the type of unified approach to the laws of nature that Einstein sought in his unified field theory, with thematic origins that can be traced back to Faraday's field concept and to Spinoza's philosophical outlook, as well as to much older themes in the history of science, going back to ancient Greece, such as Plato, Heraclitus and Parmenides, as well as to ancient Asiatic views, such as Brahmism, Buddhism and Taoism.

It has been my contention that to represent different aspects of the physical universe in terms of a patchwork of desparate theories and hypotheses, for different sorts of phenomena that occur in varied dimensions and under different sorts of physical conditions, is not philosophically defensible. [1] The main problem encountered, with this patchwork view, is that there must be absolute lines of demarcation between the different domains, where logically incompatible theories are applied. That is to say, if the basic principles that explain material phenomena in one domain are logically incompatible with those that are supposed to explain other phenomena, in a neighboring domain, then if at the 'boundaries' between the different domains one must apply both sets of principles simultaneously, because there is no sharp criterion for turning one set of principles off and another on, one could be left with a required set of principles there that are not mutually self-consistent. The only solution, then, is to envision a single unified approach to our understanding of the universe, applied to all of its domains.

II

During the Renaissance period in 16th and 17th century Europe, opposing views of the physical laws of the universe — a view of 'particularity' versus a holistic view — were highlighted. Galileo's, Newton's and Decartes' comprehensions of the universe were in terms of the particularity of its individual constituents. There were sharp demarcations between 'object' and 'subject', between 'influencer' and 'influenced' and between 'mind' and 'matter'.

Spinoza's contrasting comprehension, in the same period of history, entailed a universe based on a fundamental oneness wherein there are no individuated parts,

that is, where there is no foundational difference between things, e.g. between rocks and trees, between 'observer' (subject) and 'observed' (object), or between human beings and their environments.

In modern physics, this conflict in our understanding appears in the contrasting view of matter according to the quantum theory and the theory of general relativity, each seen as a fundamental law of matter. Important differences of these approaches are both in their epistemological and ontological implications. The quantum view presents an approach to knowledge that is compatible with logical positivism, whereby only the observables can relate directly to what it is that can be known. On the other hand, the field concept of general relativity theory takes the epistemological stand of realism. This is the assertion that indeed a real world exists that is independent of whether or not some of its physical phenomena may be observed by us and represented with our languages. This is a philosophical approach that I have called "abstract realism", in the sense that there is a part of reality that underlies the manifestations of the universe, in any of its domains, which we come to understand by means of reasoning from abstract principles (universals) to the conclusions (particulars) — based on a hypothetico-deductive method. In this way, our knowledge of the universe comes from ideas that are not directly sensed by us, but do have implications in regard to the empirical features of nature. [2]

The field concept is based on the idea that the variables that solve the laws of matter (the laws of physics), regarding any of the manifestations of the physical universe, are nonsingular and continuous, everywhere. In physics, this idea goes back to Faraday ; [3] from the stand of philosophy, it may be traced to Spinoza. This is an approach that carried forth, then, from Spinoza to Faraday to Einstein.

It is salient that Spinoza's ontological outlook eliminates any absolute lines of demarcation between the 'subject' and the 'object'.[4] This approach is also a general feature of Einstein's field theory in general relativity. It seems to me that any alleged separation between the 'subject' and the 'object' is a separation between epistemology and ontology — between what it is that we can know and what it is that exists — in different levels of comprehension. For what it is that we can know, as human beings, is indeed prejudiced by our sensing apparatuses, which are there to give us the impression that 'other' is an absolute entity, outside of us. But this preconceived model of the universe — the notion about particularity as an absolute — is a naive notion since there could certainly be more to know than the ideas based solely on our immediate perceptions. Our sensing apparatuses are, of course, tied to our perceptions of the world. It is most likely that a beetle senses the world quite differently than we do as humans. Yet, we are both sensing the same world!

Thus I believe that it would be illusory to think that our perceptions tell us about an *absolute* 'other', an object that we look down on as though we were *absolute* subjects. The contrasting holistic view is that there is only one universe without parts — though characterized by an infinite number of possible manifestations. In this view, all possible 'knowers' are among the infinite spectrum of manifestations of the single universe ; 'subject' and 'object' are then aspects of a single system that are relative to a reference frame, and therefore subjective entities, while it is the subject-object relation that is fully objective — independent of reference frame.

Spinoza called this infinite spectrum of manifestations of the real world its "modes". They are not additive parts of the whole. Rather, they are each a mode of behavior of the entire universe — just as a ripple is not a separable entity, apart from the pond in which it is seen to exist. In this sense of oneness in Spinoza's philosophical outlook, he came close to the holistic views of the universe that were held in ancient times in Asia, millennia before his own time. The views of Brahmism, Buddhism and Taoism, as well as in Spinoza, extend beyond the inanimate world of physics so as to include humankind. That is to say, with this approach, humankind is only one of an infinite spectrum of modes of the closed system that is the universe. [5]

The analogy with the relation of a ripple to a pond follows. The ripple's momentum, its energy and so on, are seemingly separate qualities of this entity, as a 'thing-in-itself'. But in fact these qualities are not independent of the whole pond. In the existentialist approach of Jean-Paul Sartre, the ripple may be considered as *pour soi* rather than *en soi*. In addition to the absolute inseparability of the ripple from the pond, as a 'thing-in-itself', its full set of physical parameters are indeed intimately related to the parameters of the whole pond — its variation in depth from one place to another, its temperature gradients, its boundaries, and so on. At first glance, it may seem that the ripple is behaving (moving at certain speeds, colliding with other ripples, etc.) as though it were an individuated entity. But we are aware that the ripple cannot be separated from the pond as a free thing, and then observed with its own set of qualities !

This view of the ripple in terms of the wholeness of the pond is similar to the Spinozist view of humankind as one of the manifestations of the universe. This not only entails the human being's molecular configuration and consciousness, it also involves the ethical dimensions of good and evil, the concept of justice as well as other societal relations, as features of this particular mode of the universe as a whole, just as it is the case in the ancient Oriental philosophies and some of those of the West.

IV

The basis of Einstein's theory of general relativity is essentially a single idea : "the principle of relativity" (also called "the principle of covariance"). This is the assertion that the laws of nature must be a set of relations that are independent of the reference frame in which they are expressed — by any particular observer who wishes to make the comparisons. This is equivalent to saying that the laws of nature must be totally objective.

There are two tacit assumptions implicit in the principle of relativity. One is that there are laws of nature in the first place, that govern all of the manifestations of the physical universe. The second assumption is that the laws of the universe may be comprehended and expressed by us in an analytical way.

The assumption about the existence of the laws of nature alleges that for every 'effect' in the universe, there must exist a logically connected 'cause'. The 'law of nature' is then the relation between the cause and the effect. In the different periods in the history of science, there has been focus at some times on 'effects', in the periods of phenomenology (for example, in present day elementary particle physics). At other times there has been more focus on the 'causes', such as the views of the Aristotelian philosophers. The tacit assumption in Einstein's philosophy, as in Spinoza, is that there is no absolute separation between 'cause' and 'effect'. Rather, what it is that is fundamental here are the relations between effects and their causes, where the names, 'cause' and 'effect' are only relative to particular reference frame, while the 'cause-effect relation' itself is an objective entity, independent of any reference frame. The tacit assumption that all effects are logically connected to causes, in the relative sense mentioned above, is then an assumption that the universe as a whole is characterized by a total intrinsic order.

The laws of nature that relate causes to effects (and vice versa) are then laws of phenomena, while the theory of relativity is a law that overrides them since it is not, directly, a law of prhnomena; it is rather a law about laws. Since a law would not be a law (by definition) if it were not totally objective, it follows that if we should accept the idea that there is total order in the universe, the principle of relativity is necessarily true — since it rests on the assertion that every effect in the universe is logically connected to a cause. However, this is a contingent statement about nature, i.e. it is not necessarily true. Thus, the principle of relativity must also be contingent on nature and in principle refutable. This principle may then be classified as a "scientific law".

V

Let us now discuss the implications of Einstein's principle of relativity together with the Spinozist holistic view that asserts that there is no absolute demarcation between the 'subject' (observer) and the 'object' (observed). According to the principle of relativity, the laws of nature must be independent of the reference frame of space and time measures — even if these, for convenience, may be associated with 'observer' and 'observed'. That is to say, by interchanging the reference frames associated previously with the 'observer' (say, a measuring apparatus) and the 'observed' (say, an electron), there should be no change in the overall objective 'observer-observed' interaction. This symmetry, according to the Spinozist philosophy, is, of course, in contrast with the lack of such symmetry, according to Bohr's interpretation of quantum mechanics.

On the macro-scale, if the interaction between the earth and the sum should be described from the reference frame of the earth, where an observer is looking at the sun, or, on the other hand, if the earth-sun interaction should be described from the view of an observer on the sun, in looking at the earth, there should be no difference in their overall description of the interaction. The invariance of the form of the law of this interaction is the asserted "covariance" that is postulated by the theory of relativity. We see then, with Galileo, that there is no absolute center of the universe, and that it is equally true to say that the earth moves relative to the sun (as Copernicus asserted) as it would be to say that the sun moves relative to the earth — just as long as the law of their interaction is independent of the reference frame from which it is described.

According to Einstein's principle of relativity, then, the objectivity of the laws of interaction in nature should be independent of the type of force exerted by one of the interacting components on the other, their respective masses, and so on — whether we are discussing a star-planet system, a star-star system, an interaction of galaxies, or if we are discussing the interaction between a laboratory-sized apparatus with an elementary particle of matter. It is the logical requirement of the principle of relativity that the spirit of Newton's third law of motion — the law of action and reaction — should underlie any interaction, even if it is between a 'knower' and the 'known', i.e. between a subject and an object.

In some applications of this view of a closed system, if the parameters of a component of the total system are very large compared with those of another of its components, for example the mass of the sun compared with that of the earth, in their earth-sun interaction, it is certainly a good approximation to neglect the reaction of the sun to the earth, i.e. the recoil of the sun, due to its reaction to the earth's

motion. Still, in view of Newton's third law of motion — as an exact part of the theory — as well as Einstein's field theory for a closed system, such recoil must be taken into account in the theoretical expression of the sun-earth interaction, as a closed system. Similarly, in the exact expression of a physical law of coupling between a macroapparatus and a quantity of micromatter, one must, in principle, take account of the reciprocity between their mutual interactions — of the measurer and the measured. It then follows that all of the material components of a closed system must be represented in terms of the same types of (covariant) variables, solving the same sorts of covariant laws. This conclusion that comes from the Einstein approach to a material system as closed at the outset, is, again, in contrast with the assertion of the Copenhagen school.

The implication of this logical requirement of a physical system, following from the theory of relativity, is that a comprehension of the universe, without any approximations, must be based on treating it at the outset as a closed system — a system of matter that has a fully objective representation, whether or not we may ever be aware of its total form. For, in this view, there can be no absolute separation between the 'subject' and the 'object'; since one may arbitrarily interchange these names without in any way altering the objective description of their interaction. Again, this conclusion from Einstein's field approach to physics, unapproximated, is in full accord with Spinoza's holism in his view of the universe as a closed system without any actual separation into 'parts', though entailing an infinite spectrum of distinguishable modes (manifestations).

Along the way, we have seen that, in addition to Spinoza's philosophical stand, one other important precursor for Einstein's theory of general relativity, as a theory of matter, was Newton's third law of matter — the law that asserts that for every action of one matter component of a system on another, there is another action of the affected matter on the source of its effect, that is a force of equal magnitude and in opposite direction from the force exerted on it. It then follows from Newton's third law of motion that any physical system, for example, the entire universe itself, is necessarily closed.

The closed system that is implied by Newton's third law of motion is then a single system. It is only when one 'artificially' considers this closed system to be a set of independent entities that are separable from each other that this single system appears to be a many-body system. Nevertheless, in principle the components of the single system we consider may not be separated from each other and their mutual interactions made to vanish. This is because any force the matter exerts on other matter has

infinite range — the gravitational and the electromagnetic force, as well as the so-called 'short-range' forces in the nuclear domain.

This feature of infinite range for all of the forces in nature is a natural consequence of the theory of relativity. For if a natural force would have a finite range, there would have to be a place in space, relative to one interacting component of a system, where the mutual force would 'cut off', thereby separating one type of phenomenon, such as the (strong) nuclear force, from another, such as the electromagnetic force, that acts between components of the material system. What is inconsistent here with relativity is that, in the context of this theory, a space-time transformation is supposed to maintain the form of the law of nature (according to the principle of relativity). But, instead, it would displace the place in space where the cut-off occurs. That is to say, a cut-off in force cannot be absolute so that, to one observer, the nuclear force would be off and the electromagnetic force on, while to another observer, the nuclear force would be on and the electromagnetic force off !

A resolution of this problem would be to assert that all phenomena act in all domains, though one type or another dominates under particular physical conditions. It must then be concluded that, in relativity theory, all forces in nature have infinite range, and they are all unified in a common field of force. This was the idea of Einstein's unified field theory.

VI

In progressing from the Newtonian view in classical physics to Einstein's view in general relativity, an important change is from the atomistic ontology to that of a continuum. In Newton's approach, each of the atomic constituents of the universe must be coupled to all of the remaining constituents. This follows from the application of Newton's third law of motion. But in Einstein's field theory, it is a generalized sort of motion that distinguishes one reference frame from another — say that of the 'observer' from that of the 'observed'.

"Motion" is defined explicitly in this approach in terms of the continuous rates of change of one set of language parameters with respect to another set, such as the 16 components of the rates of 4 space-time coordinates of one frame with respect to the 4 space-time coordinates of another. This underlying definition of the way of distinguishing one reference frame from another, in accordance with the principle of relativity, then implies the very significant result that the (dependent) variables that most basically represent matter must be *continuous functions* of the (independent) space and time variables. This view then rules out the atomistic model of a physical

system, whereby the independent variables would be the discrete parameters that locate the particle trajectories, as it is in classical physics.

Summing up, then, the theory of relativity implies that there are no absolute lines of demarcation between discrete quantities of matter, that make up the substance of the universe. The universe is then chracterized by continuously distributed matter field, without any singularities.[6] This model is in contrast with the atomistic views, in classical physics, as well as quantum physics. It is also in contrast with contemporary astrophysical models that entail real singularities in space and time.

VII

The next step beyond Newton's third law of motion, applied to the universe as a closed system, would be to abandon the separate trajectories of the 'things' of the universe, $[r_i (t)]$, where i=1, 2, 3, ..., n, for an n-body system, and proceed to the field concept, wherein the substantive physical system is characterized by n continuous (and continuously differentiable, that is to say, "analytic") functions, all mapped in the same space-time $[\psi_i (r, t)]$. Conceptually, this is the idea of the field theory that Faraday came to in his 19th century studies of electricity and magnetism, and his generalization of their union into a unified electromagnetic field. He also tried to incorporate the gravitational manifestation of matter with electromagnetism, but he did not succeed in this task.

A giant intellectual step was taken in the history of physics when Faraday expressed the idea that the set of continuous fields, $[\psi_i (r, t)]$, must replace the singular trajectories, $[r_i (t)]$, as the fundamental variables of matter. [7] This was indeed a significant step toward the rejection of the atomistic model or matter, wherein the universe is viewed as a sum of discrete parts : atoms, planets, galaxies, clusters of galaxies, and so on.

In this context, it is interesting to note that one of Faraday's chief motivations that led him to the field concept, was his wish to replace the Newtonian concept of 'action-at-a-distance' — a concept that Newton himself felt uncomfortable with, though he excused his discomfort with a comment that he did not form hypothesis ! [8] Faraday's rejection of this concept led him to the more abstract view, in which the singular quantities of matter are rejected, as derivative, and are replaced with a set of continuous fields of potential influence. [9] This (Aristotelean) potentiality was then to be actualized by a 'test body', wherever it may in space, in order to feel the influence

of the other matter — there and then. This is then a replacement of 'action-at-a-distance' with 'action-by-contact', that is, the contact between the test body and the field of force of the other matter.

Faraday's approach is then not holistic in the sense of a closed system, as it is in Spinoza and Einstein. This is because he still considered that the net influence that is due to a set of matter components of a system, on a test body, is the linear superposition of the fields of the latter, wherever the test body may be located. Nevertheless, there is a logical inconsistency here in the use of a singular test body in the overall description of the closed system. In principle, if the closed system would be consistently described, without approximation, there could only be continuous, nonsingular fields making it up, all mapped in the same space and time. It is only when one of these coupled, nonlinear fields is asymptotically approximated by a weakly coupled object, appearing to be a singular body, that one may call it an impartial 'test body', that is there to probe the rest of the field.

Einstein's discovery of the field concept grew out of Faraday's notion of the field. While Faraday's conception was in terms of a continuously distributed *potentiality*, Einstein's interpretation extended from this idea to a continuously distributed *actuality*. The component fields of Einstein's approach are not generally separable into a linear sum of fields, as it is the case with Faraday's approach. This is because of the closed nature of the universe, in Einstein's theory. In his view, the 'test body' does not exist as an absolute subject, looking at the rest of the system as an absolute subject, looking at the rest of the system as an absolute object. The 'test body' rather emerges as a mathematical approximation for a nonlinear formal description of the closed system, where it appears to be (almost) uncoupled from the system that it is there to probe. But in reality, the 'test body' in Einstein's general relativity theory, is just as much an integral feature of the entire unified field as any other of its field components. This conceptual view of the intrinsically closed nature of the universe, according to Einstein's theory, is in full accord with Spinoza's holistic philosophy of the universe.

VIII

It is interesting to consider the cosmological view of the universe from the standpoints of Einstein and Spinoza, compared with the contemporary cosmological models in astrophysics. Most of the current views of the astrophysicists on the problem of cosmology use the language of general relativity theory, yet they do not pay strict attention to the scientific requirements of this approach.

The most widely accepted model in contemporary cosmology is the 'big bang theory'. To discuss this point of view, it is important to distinguish between the idea of a single big bang' and the idea of an indefinite number of big bangs, as one would encounter with an oscillating universe cosmology. The single big bing entails an absolute, global time measure for the universe as a whole, a measure that is with respect to the origin of time = the beginning of the universe. This idea of an absolute time measure is incompatible with the subjectivity of time measure, according to the theory of relativity.

With the oscillating universe cosmology, on the other hand, different galactic observers would disagree on the age of the cycle of the universe since the last big bang, since there is no absolute time measure here, in accordance with the relativity of time. But all observers would agree on the form of the cause-effect relations that govern the behavior of the matter of the universe.

Thus we see that, because of the absolute role of the 'beginning' in the single 'big bang' cosmology, this is not a covariant theory of the universe — i.e. it is not compatible with Einstein's general relativity. However, the oscillating universe cosmology is compatible with the principle of relativity so long as one maintains the subjectivity of the time and space measures in expressing objective laws of nature — including the dynamics that underlies the motions of all of the galaxies relative to each other.

Summing up, as I see it, the only contemporary cosmology that is compatible with the theory of relativity is the oscillating model. Here, there is no absolute beginning or end for the universe. Instead, the universe is characterized by indefinite repetition, similar to the cycles of the seasons of Earth. Thus, when the expansion that we now observe changes to a contraction, the universe will implode inwards and eventually vaporize all matter, as we now know it, including the human race. But this will not be an absolute end. For, after this inflection point, when the predominantly attractive mutual gravitational forces between the imploding matter components of the universe turn to a predominantly repulsive force, there will be an explosion once again, as there has been an indefinite number of times in the past. After the next explosion, galaxies and planents would eventually form again, and life as we know it would reappear, as it has an indefinite number of times in the past. The cycles of the universe would continue indefinitely in this fashion, because of the closed nature of the universe, according to the theory of general relativity. The questions about the actual beginning of this oscillating universe, that we experience, and the cause of it, are out of context in regard to the physical problem of cosmology.[10]

A very poignant remark that Einstein made was that the most incomprehensible thing to him was that we are able to comprehend anything at all about the universe. Reflecting on his comment, one cannot help capturing the awe that he and Spinoza must have felt in their realization that our human capacity to think and reason can in fact lead us to any comprehension of the physical universe, small as this understanding may be at any particular stage.

NOTES

1. I have discussed this problem in the context of Popper's 'three world concept' in : M. Sachs, "Popper and Reality", Synthese 33, 355 (1976).
2. The comparison of the philosophical bases of the quantum and relativity theories are discussed further in : M. Sachs, EINSTEIN VERSUS BOHR (Open Court, LaSalle,1988), Chapter 10.
3. For a discussion of Faraday's views, see : J. Agassi, FARADAY AS A NATURAL PHILOSOPHER (University of Chicago, Chicago, 1971).
4. The essence of Spinoza's philosophy is in : B. Spinoza, ETHICS (Dover, New York, 1955), transl., R. H. M. Elwes.
5. General discussions of the Indian and Chinese philosophical outlooks are : C. A. Moore, editor, THE INDIAN MIND (University of Hawaii, Honolulu, 1967), W.-T, Chan, A SOURCE BOOK OF CHINESE PHILOSOPHY (Princeton university, Princeton, 1963). This philosophical view is discussed further by the author in his book : RELATIVITY IN OUR TIME : From Physics to Human Relations (Taylor and Francis, London, 1993).
6. The rejection of singularities, everywhere, follows from the use of *Noether's theorem* - which ensures the incorporation of conservation laws into physics. For a theoretical discussion of this theorem, see : C. Lanczos, THE VARITIONAL PROBLEMS OF MECHANICS (University of Toronto, Toronto, 1962).
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9. In contemporary times, this view is akin to the notion of "powers", clearly expounded by Rom Harre, in his THE PRINCIPLES OF SCIENTIFIC THINKING (University of Chicago, Chicago, 1970), pp. 269-284.
10. This is discussed further in the author's article, "On the Problem of Cosmology", Physics Essays 6, 32 (1993).

SCIENCE PHILOSOPHY INTERFACE
VOL. 1 JULY-DECEMBER, 1996 NO. 2

COSMOLOGY AND PHILOSOPHY
the Ancient Indian Panorama*

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and

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Cosmology is the branch of astronomy which deals with the basic questions asked by the human beings from the time immemorial. It is, in fact, the supercluster of glittering objects and their movements in the sky, that astonished the ancient people and provoked them guessing and thinking. It is for this reason, astronomy becomes the oldest of all branches of science. Cosmology deals with the creation, evolution as well as the fate of all matter and energy forms of the universe, that is, the large-scale behaviour of universe. In this last decade of the twentieth century, the scientists are in a position to answer some of the questions pertaining to the evolution and, only in smaller extent, to the creation of the universe. This quest for the truth related to the creation occupied the minds of the philosophers also in various regions of the world from the ancient times. Thus, the part of the cosmology which deals with the origin or the creation of our universe remains the common deliberation of the cosmologists and philosophers and it will be interesting to discuss the extent of the achievement of the ancient philosophers, particularly, of the Hindu philosophers of Vedic period.

As we are talking about the origin of the universe, then it is presumed that the universe has a 'beginning'. In modern cosmology, the relevant theory is the big-bang origin, that is, the birth of the universe in the primordial explosion. This theory is, in fact, one of the two rival theories of cosmology that dominated discussions during 1950's and early 1960's. The other theory is the steady-state theory proposed by Herman Bondi and Thomas Gold in 1940's and also by Fred Hoyle in a somewhat different way. In this theory, the universe has always been just about the same as it is

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* *This article is based upon the talk delivered by one of us (SSD) at the International Symposium on Indian and Other Asiatic Astronomies held on December 12 - 16, 1991 at Hyderabad, India*

now. Both the theories were developed to account for Edwin P. Hubble's discovery in 1929 that the universe is expanding. The big-bang model considers that the universe in the beginning was hot and enormously dense with matter and energy and that as it has expanded it has cooled and become less dense. On the contrary, the steady-state theory states that as the universe has expanded, its density has remained constant by the creation of new matter continually, that fills up the gaps between the galaxies. In this theory there is no early universe or the origin of it.

In the 1960's the big-bang theory received several observational supports and by the 1970's it was the clear winner. One important observational support came from the discovery made by Arno A. Penzias and Robert W. Wilson of the Bell Telephone Laboratories. If the big-bang model is correct, at one time the universe would have been so dense and hot that the matter therein would have generated a characteristic spectrum of thermal radiation which does not arise for the steady-state theory. Penzias and Wilson discovered a microwave background radiation which confirms the hot and dense scenario that is possible in the big-bang model only.

The strongest boost in favour of the big-bang model comes from the studies of the primordial nucleosynthesis, that is, the formation of the elements. In fact, temperatures nearly hundred million times the room temperature are required to forge many elements from protons and neutrons which are the building blocks of all atoms. Such temperature would have occurred about one second after the big-bang. It is possible to study the situations of that epoch that is, one second after the big-bang, from the measurement of the present relative abundances of the elements. Now, the predictions based on nucleosynthesis during the early stages of the universe (i.e., during the first few minutes after the big-bang) are found to be in conformity with the observed abundances of the light elements at the present times.

In order to understand the creation phenomenon of the universe we have to push back to earlier times that one second after the big-bang. But before discussing this phenomenon, it is to be noted that in the big-bang model of the universe there are two distinct possibilities regarding its evolution. The first one is the case of 'open universe' in which the universe is infinite. The density of matter and energy therein is less than some critical value and the expansion, though slowing down, will continue forever. The other case is the 'closed universe' in which the universe is finite and the density is greater than that critical value. The expansion will eventually cease and be followed by a contraction. Thus, the density of matter and energy can decide the evolution and fate of the universe. Present observations show that the density is much less than the critical density but it is conjectured that more matter in the form

not yet detectable, that is, in the dark matter form, might exist in the intergalactic regions, that could close the universe.

Now, if we make our journey backward in time from the universe-epoch of one second, the temperature will increase enormously and at the planck time 10^{-43} second after the big-bang (which is the time-origin) the temperature will be as high as 10^{32} degrees Kelvin. In fact, we must face infinite values for temperature, matter density etc. at the very 'origin' of the universe, that is, there is singularity at the very beginning of the universe. Cosmologists are trying to avoid this singularity through various kinds of modifications in this standard model. Even if, there is no initial singularity, the matter and energy or the so called entropy must have to be created in the very early stages of the universe in order to have the present entropy of the universe, which exists mainly in the form of balckbody radiation.

Now, such a creation is not permitted in the present universe because of the well-known energy-momentum conservation law, a phenomenon which is confirmed by physical observations. Such a creation of energy and matter is indeed possible in the early stage of the universe near the planck time and this scenario is known as the inflationary stage of the universe when the expansion rate of it is similar to that of the steady-state model to which creation of matter is generally associated. Although the matter can be created in the inflationary universe but the burst of entropy associated with the creation of matter is only possible in a thermodynamically open universe proposed recently by I. Prigogine and his collaborators. Now, where did all the matter and energy come from violating the energy and momentum conservation law ? It is, indeed, the space-time curvature, a property or geometry of the space-time itself, that is converted into the matter or energy form. This 'transition', in fact, occurred quantum mechanically, a scientific phenomenon for the very minute building blocks of the matter and energy. Thus, the present cosmological knowledge about the origin or creation of the universe is a possibility to the extent that the universe may have been created from the space-time curvature, that is, from 'nothingness' but from the abstract property of the space-time. Of course, in laboratory, such theory can not be tested, at least in the near future because all these things can occur at very high energy (say, 10^{19} billion electron volts) which is far beyond the present capacity of the technology of our blue planet. Thus, in a sense, this type of physical theory seems to be philosophical in character and is suitable for an evaluation of the achievement of the ancient philosophical thoughts of the East and the West. Also, recently the scientists have made connections between the behaviour of the elementary particles and the large-scale properties of the universe. In this connection we can mention that the elementary particles can be thought as the microuniverses.

This idea which has been advocated by Erasmo Recami very recently is based on the empirical coincidence between the ratio in some of the entities of the micro-and macro-world as pointed out by P. M. Dirac. In fact, the ratio in the strengths of gravitational with strong interaction forces and that in the typical hadron radius with the Hubble radius of our cosmos are found to be the same and equal to 10^{-41}. It, thus, might give that the 'small' may resemble 'large'.

The Indian philosophy was fully grown up in the Upanisads or in Vedanta. But, in the Vedas it has the origin and, in fact, from the Vedas the Upanisads developed. These philosophical thoughts are clearly related to the cosmos. In fact, there are ample examples that are related to such philosophical thoughts about the creation of our universe, even before it. Three such hymns are from the Atharva Veda (A.V. 19-6-7, 19-6-8 and 19-6-9) where it has been described what was before the creation. Kama, the personification of desire or seed arising out from the previous Kalpa, the whole period of an universe in its contraction or expansion phase, is regarded as the active form of the inert creator. There, Kala, the time personified as the primordial power and the first god, now hastens onward. It is described there "by him this (universe) was urged forth, by him it was begotten, and upon him this (universe) was founded. Time, truely, having the brahma (spiritual exaltation), supports Parameshthin (the highest lord)". Also, "the self-existing Kasyapa and Tapas (creative fervour) from Time were born". Further, "from Time the water (sound or plasma?) did arise, from Time the brahma (spiritual exaltation), the Tapas (creative fervour), the regions (of space did arise)". In other A. V. hymns, like 9-2, 9-1-2, the desire for creation, that is, Kama has been praised and described as to be the superior entity which was created first. Before comparing with the modern cosmology we must cite few other hymns from the Vedas. In A.V. 4-1-2, it is described that the created latent and revealing diverse forms and entities of the universe are related causally to Bendeva, which was within and all pervading in his creation. In A.V. 1-3-2, God has been described as sound and light energies as well as the space entity. The famous Nasadiya Sukta 10-129 of the Rg Veda describes the whole creation phenomenon in details. It is, in fact, the space-time (in modern terminology) that existed even before the creation. From this mysterious darkness (that was impossible, according to the sages, to understand) the great desire for creation came and the revealing universe (Sat) has originated from Asat (the latent and non-revealed form). In the Taittiriya Upanisad 2-7-1, it is clearly stated that before the creation the universe manifested in the diverse forms and entities was in the latent or inactive form, the Brahma. From this (Asat), the revealing universe (Sat) was created. It was He (Brahma) who did himself likewise and for this reason He is known as Sukrta (the self-ruler). That the creative power is

within the creation has also been contended in other Upanisads. It is much explicit in the hymn 3-14-1 of Chandogya Upanisad. Such assertion was also made in the Taittiriya Upanisad in several hymns. There it is clearly stated that the creation occurred from Akasa (the space-time in modern terminology). Questions about the creation and the natural phenomena have been raised also in R.V. 1-164-4 and 5, as well as in 6-3 of Svetasvatara Upanisad. Akasa in the Indian Hindu philosophy unlike Buddhism, is regarded as an entity with property and dimensions. In Buddhism, on the other hand, it is not an entity but only void, that is, complete emptiness. In modern science and cosmology, even vacuum is not complete emptiness and as mentioned earlier, the creation of all matter, energy and entropy, that is, the cosmos, has occurred from the space-time property. There, it has been shown that some type of fluctuation in the space-time 'property' is the cause of the creation. This fluctuations in the geometrical property of space-time can obviously be identified as the seed or desire, the personified Kama of the latent supreme entity. According to Nyaya school of thought the universe is made from the atoms. It is also stated that there remains so much atoms in so far monvisible form in the Akasa such that another universe much greater than ours could be build out of them. This idea clearly points out the possible existence of dark matter form in the universe as conjectured by the modern cosmologists. Already it is pointed out that in a closed universe there is one expansion and the other contraction phases. The phases can be indentified as the Kalpa of the Vedic and Puranic literatures, which represents a period of 4.32×10^9 years. This period is, in fact, to the same order of the present age of the universe, which is 13 to 15 billion years as calculated in modern cosmology.

Lastly, I like to remark that the ancient Greek philosophical thoughts are also in conformity with, in some extent, the modern scientific thoughts. In fact, at present the elementary particles are regarded as the microuniverses as pointed out earlier and this idea is similar to that of Democritus of Abdera (400 B.C.) who considered that each microscopic 'particle' of matter might be something like a whole 'cosmos' — extremely reduced in size. Democritus, by reversing the analogy, also spoke about giant atoms which could reach the size of our cosmos, and, in order to be clear, he added : if one of such superatoms (that constituted supercosmoses) would leave its 'giant cosmos' and fall on our world, our world would be destroyed. Plutarcus (~ 135-51 B.C.) another Greek philosopher commented "matter possesses a cohesion that keeps it together and against which the vacuum is impotent. Actually, the material world is supported by an immense force, and alternatively it contracts and expands following its physical transmutations, now consumed by fire, now giving rise to a new cosmos creation". This comment is quite relevant in modern cosmological thoughts.

It is worth mentioning that the Greek philosophers were influenced by the Indian philosophical thoughts of the Upanisads. An ancient Greek author Eusibius wrote about an interesting conversation between Socrates (470 B. C. - 399 B.C.) and an Indian scholar in Athens. Also, E. J. Urwick in his book 'Message of Plato' analysed the influences of the Upanisads over Plato (427 B.C. - 347 B.C.). After Alexandar's invasion to India (325 B.C.) this cultural relation was firmly established. In this article, an effort has been made just to point out that the present scientific thoughts related to the universe, its creation and evolution, take its course towards the philosophical thoughts of ancient seers achieved through their logical and profound thinking or by meditation.

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SCIENCE PHILOSOPHY INTERFACE
VOL. 1 JULY-DECEMBER, 1996 NO. 2

CREATION OF MATTER :
Traditional Indian Thinking and Modern Science

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"Or he might ask me to discuss some of the wonderful foundation stones of cosmology ... as we see them today" "It would be an even greater challenge and joy to ferret out to discuss every clue and every writer in every domain of thought that promises significant potential clues in the insight on "How come existence" ..... philosophy is too important to be left to the philosophers. Search out fragments that come down to us from the writings of the presocratic philosophers and some of the later thinkers"[1]

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Contrary to what the title may suggest we will mainly discuss here the views of one of the major schools of thought which developed in India long back. Our brief references to modern science will be made not for the purpose of comparative study of the problem of material creation but in connection with the discussion of the following related problem.

Can the example of traditional thinking about physical creation which we discuss in the second part of this paper be taken as providing material for science philosophy interface ? Part one searches an answer to this question in a rather indirect way. Thus this paper — or the study of the problem of physical creation —may also be viewed as a case study in relation to the wider problem of interface between science and philosophy. There are other problems, the discussion of which may be viewed similarly.[2] Many scholars are not prepared to think that interconnection between science and philosophy is a realized fact. Some of them again question the very possibility or even desirability of it. The problem we discuss in the first part may at the same time

* *This research has been partly supported by Indian National Science Academy, New Delhi, under its project : Indian Science — A Logical-Historical Study of Some Physical and Mathematical Concepts in Indian Tradition.*

suggest in an important way a possible line of answering the question about interface between science and philosophy.

What we intend to discuss directly in the first part is the question whether traditional thinking about creation of matter or discussion of such old views can have any value today when so much progress has been achieved in the field by modern science. We will select the example of traditional thinking in question, which we will discuss in the second part, from the literature of Indian philosophy. The language of this literature in its original form is Saṃskṛta*.

The two parts of this paper have been kept nearly independent of each other and so the understanding of one of them will not presuppose knowledge of the content of the other part. The parts therefore can also be read in any order one likes.

I

I.1 In the next section we will discuss more systematically and elaborately the question which has been raised about the usefulness and relevance of traditional thinking on the subject in question. But before that we would like to state in a general way and very briefly what stand we take in the matter and why.

As suggested above this question of relevance and value gain special significance in the context of the prospect or otherwise of science philosophy interface. It is not easy to establish today that such interface exists between the two disciplines of thought, even if we take the two disciplines to belong to the same culture, say, the Greco-European culture. It appears still less convincing if one claims that the sort of interface in question exists or can be developed between science and philosophy when these disciplines belong to different cultures, and different times, say, modern European science and ancient Indian philosophy. But we believe that traditional thinking in this area of human knowledge is more than a matter of historical interest; and that the words of Wheeler quoted above expresses more than a sentiment ; it contains a sound advice. Those who believe otherwise and say that the traditional thinking in the matter has been rendered useless seem to do so because all or some of the following are true about them. They have forgotten that the history of science witnessed in the past so many instances of recovery and currency of ideas and theories which were once lost or rejected. They never took the trouble to clarify to themselves or to others what they understand by the word tradition. They have not paid sufficient

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* The word Sanskrit, which is more commonly used and which may be found in English dictionaries, is the anglicized form of the word *Saṃskṛta*. We have studiously avoided the use of anglicized form of *Saṃskṛta* words in the text.

attention to clarifing their notion of science, philosophy and the relationship between the two in the context of same or different cultures. They have not perhaps carefully considered the fact that the cosmological thinking of the contemporary physicists is more philosophical and speculative than experimental and scientific. Again they are not sufficiently attentive to the fact that today there is nothing like *the* scientific theory of the origin of the universe ; there are still many controversies or, at least, uncertainties. They are not explicitly aware of the fact that prudence demands that in such a situation we cast our eyes in all directions if perchance we can get some clue in some unexpected corner of human knowledge including traditional philosophical thinking of some culture or other. Even when we cannot allow ourselves to dilate on many aspects of the problem which the traditional thinking may bring to our notice, the awareness that these aspects are there may broaden our view and vision and enable us to make a more reasonable and accurate estimate of the value of a scientific theory of creation.

I.2 We shall dwell a little on a number of situations or possibilities with a view to answering the question — or, still more fundamentally, to understanding the question — about the usefulness of discussing in modern times the views of the thinkers of bygone ages. Professor J. V. Narlikar, among others, has raised this question and raised it most authentically.[3] What answer one gives to this question will depend on which situation or possibility one believes to hold or believes to have been actualized. If a situation of type (S_1) obtains then it would make sense to study and, if possible, further develop (philosophical) thoughts or discussion on matter of earlier days irrespective of what progress has been made by modern science in the last three hundred years. If the second type of situation (S_2) obtains then attempts at recalling, reviving or even reconstructing the thoughts of ancient people will appear as sheer waste of time or as serving merely historical curiosity. If however, a third type of situation (S_3) holds then rethinking the thoughts of the past people may still have some useful purpose to serve in the age of modern science.

(S_1) Even when they seem to be the same the problems which are discussed respectively by the philosophers and scientists are actually different so much so that progress in science or lack of it in philosophy has little or no implication for philosophy or science. When an astro-physicist inquires about the origin of the (observable) universe the size of which is approximately 10^{26} meters, he is asking a question different from what an ancient seer sought to answer by saying *ānandyāt-eva-khalu-imāni-bhūtāni-jāyante* or that God Himself became this whole universe because such was

His wish! Those who believe that such a situation obtains may argue in the following way. If the questions discussed are so different then progress science has made in search of the answer to its own question may not have rendered unnecessary or useless the discussion of altogether a different question which the ancient thinkers were concerned with.

We here do not want to avail of this sort of argument from (S_1). For in the first place this defence establishes at most the negative conclusion that ancient account of creation cannot be said to have been rendered useless or unnecessary. It does not show that the study of that ancient account has any value in modern times. In the second place the account or view of material creation which we intend to discuss here has been formulated in literal language and discussed in a rigorous and analytical style in philosophy. In other words, and to put it in modern terminology, we do not propose to discuss here some mythological account of the origin of the universe described centuries ago in a metaphorical language for trusting and uncritical believers.[4] The account to be discussed may therefore be judged to be very close to scientific views. Again, the world, the story of the origin of which has been reconstructed in this account, is the familiar physical and biological world of common experience.

Contrary to the picture suggested by the emergence of so many specialized areas and sub-areas within even any single discipline of knowledge, we believe, and we are not the only ones to do so, that there is essential continuity in human knowledge. And this continuity and affinity of concerns obtain not only beyond the barriers of individual branches of theoretical disciplines or knowledge but also among temporally and spatially separated traditions of knowledge. Both science and philosophy are branches of theoretical knowledge and in spite of the greater generality of them some philosophical questions are very similar to the corresponding scientific questions. Then again in some areas of science the questions asked are as broad in scope as those asked in philosophy.

It may be thought that if the situation is like this — if science and philosophy are so similar — then one may offer an argument from (S_2) to show that any discussion of ancient philosophical views about creation has been rendered unnecessary by developments in modern science particularly in astro-physics (and also particle physics). We will, however, argue later that some views propounded by ancient philosophers are still relevant today precisely because science and philosophy are so very similar in certain respects. If they were very different then achievements in one of these fields might not have any relevance for the other field of knowledge.

But let us first dwell a little on the situation (S_3). Philosophy and science are fundamentally different types of inquiry so much so even when the themes or questions

discussed are the same, the answers which the philosophers give are of no use to the scientists. The converse is also true. to be more precise, philosophy, according to some, is essentially a linguistic inquiry whereas (natural) science is a factual inquiry. Thus even when both of them are inquiring about the origin of the universe, the scientists are actually searching for the conditions which literally caused the actual event called creation of the universe; but a philosopher is inquiring about whether we can make literal sense of such sentences as 'The whole universe came to exist at a given moment of time'. Now if the two inquiries are so different in their nature, approach and orientation then nothing about usefulness or uselessness of philosophical discussion on material creation follows from the current state of knowledge in astrophysics or particle physics.

But such argument from (S_3) or defence of usefulness of the discussion of ancient views in modern age is unacceptable to all unless there are, if there are, still a few philosophers who accept the logical positivists' view about the nature of philosophical inquiry sketched above.[5]

But another version of (S_3) is there which constructs the difference between scientific and philosophical inquiry at a different level. Modern science aims at an empirical account of the origin of the universe and not a speculative or 'rational' one. So whatever may be that from which the universe came into being according to science, it must be amenable to empirical method. It is not necessary, however, that it must itself be observable to the aided or unaided senses. But, at least, the postulation or inference of it should be based on some empirical evidence or phenomena. Further, some consequences must be deducible which can be shown to tally with all the known empirical observations and evidences. For example even if a black hole is not in principle observable yet its postulation is scientific because the proposition that there exists black hole forms only a tiny part of a large theory which has at its core some strong empirical content. On the basis of this new version of (S_3) one may argue that empirical study of nature or matter and the conclusion arrived at there cannot have any direct bearing on the usefulness or otherwise of the rational and philosophical study of the same. Philosophy of nature and science of nature are two different and independent disciplines of knowledge like linguistics and aesthetics. A linguist's account, however competent it may be, of a literary work cannot render useless or unnecessary what can be said about the same work from the point of view of aesthetics.

We cannot accept this line of defence or argument — based on a new version of (S_3) — either. For science of nature and philosophy of nature are not as different as linguistics and aesthetics. Views differ in different traditions and cultures as to the

exact nature and extent of the difference which obtains between philosophy (of nature) and science (of nature). The reason why they appear so different in the West should be traced to the representative Greco-European conception of reason and sense experience on the one hand and the conception of the relationship between them on the other. We postpone our brief discussion of these conceptions till we discuss, what some representative section of working scientists of India say about modern scientific inquiry relating to matter on the one hand and the value of discussing the traditional thinking on the subject which we find in India on the other.

Narlikar, representing a section of the working scientists of India today relegates Indian philosophical theories, which originated long before modern science developed, to traditional wisdom or knowledge and then says "I do not think that attempts to demonstrate similarities between ancient traditional beliefs and the statements of modern science about nature are worthwhile. For the former are now *frozen* while the latter are evolving".[6] Though in this article we do not mean to compare the view of some Indian philosophers about physical nature with that of modern scientists yet we think it would be in order to state an alternative way of looking at tradition or traditional body of knowledge which seems to be more reasonable. This we will presently do. But it may first be noted that what other things this representative of working scientists of modern India says in the matter shows clearly that he speaks, and views things, just in the way in which a member of the Greco-European culture does or is expected to do. One who belongs to this culture by birth, education or faith learns to view science, philosophy and their relationship in a particular way which in its turn is based on certain characteristically Greco-European conceptions of reason, sense experience and their relationship. Given these conceptions (as distinct from the view so characteristic of Indian culture) what this Indian scientist says is true. But the ground he actually and explicitly offers in support of his view is rather weak. He believes that a scientist is committed not to claim finality. Even when the question is clearly formulated and he makes "progress in the right direction", a scientist cannot hope to know the final truth about the nature — about the origin or constitution of matter. As to the question whether he thinks that the problem in hand will finally be solved, our scientist is likely to say "Perhaps we never will". His reason for saying so is his belief that "the quest of science is an unending one".

This dose not seem to be a very convincing argument. For one can reasonably say that science is unending in the sense that man's quest of knowledge will never end, his thirst for knowledge will never be fully satisfied. The moment he discovers the final solution to an old problem he will discover some new questions or problems which will keep him engaged for years to come. If one has such a conception of

'science as unending' then one can hold consistently that a final answer to the question about the origin of the universe or of the constitution of matter may be found (if it has not been found already).

The real reason why a scientist of the Greco-European tradition cannot claim finality for any scientific truth is that (natural) science is, in this tradition, the study of phenomenal reality by empirical method. Such a study issues in certain general factual truths. Now since the truths are factual they are ultimately empirical or based on sense experience. But sense experience can never give us absolute truth i.e., truth that cannot in principle be revised. Reason is, however, the only means to know transcendental reality which is eternal and immutable. Truths or knowledge about such reality can be really universal and absolute. Either therefore science is not an empirical study of the observable universe or nature (or part thereof) or it is not a body of final and absolute truth. Since the predominant conception of (natural) science is that it is empirical the truths of science remains ever in principle subject to modification, revision, and possible rejection. Once we take science to be unending in this sense of the term then it is a truism to say that science cannot claim finality in favour of any one of its truths, that science cannot hope to find absolutely final solution to any one of its problems.

In the Greco-European culture, philosophy is essentially different from science. It is either a study of the transcendental reality through the use of reason (or Reason) or it is the study of language of, say, science. It is in no case a study of the empirical reality, it is not a science. Thus philosophy aims at (transcendental) rational or linguistic truth. But even when it aims at linguistic truth or truths about our linguistic usage philosophy should not be confused with the empirical study of a field linguist. Even when he is studying language the philosopher is conducting a logical or conceptual study and as such it may not be impossible to arrive at final truth; at least, the ground on which one can say that (natural) science can never arrive at final or absolute truth — the ground stated above — does not hold in case of philosophy.

It follows from our discussion that when he is not comparing and contrasting science with philosophy, and so long he keeps himself within the limits of evolving science, a practising scientist or astro-physicist can legitimately hope for or talk about final solution to certain specific scientific problem. He only cannot mean by "final" necessarily true for all time to come or non-revisable in principle. Final in this context would mean all that had to be unified or explained have been explained or unified; there is no left-over. If all this is true then we have answers to all the particular questions solutions to which were sought. There may be some new questions but that is altogheter a different matter. This may be illustrated with the example of the question about the

end of physics. It all depends on what one means by the word end. However good a unified or grand unified theory may be one cannot reasonably and convincingly say that there cannot in principle be further improvement. But even if it is possible to further improve it, and so far not absolute, a theory can be said to be a final answer to the search for unification in physics if it can provide unified description of all the basic forces of nature or at least of the following three : electromagnetic, weak and strong forces. If the physicists did not believe in the possibility of final solution or of the end of physics in the sense defined, then so many of them would not have been in this pursuit for such a long time.

This is not to deny that there are physicists who think either that search for unification is of no more than aesthetic value or that unification in the sense defined is in principle impossible. Some of them seem to define the end of physics operationally to mean a time when no government or private agency will allocate funds for research in the field of future unified theory.

Be that as it may, even if a particular question — say, the end of physics or completeness of an axiom system — cannot in principle be solved finally, it does not follow that there is any logical inconsistency or contradiction in the belief (at any given time) that at least one scientific question may be finally solved one day.

It is to be further noted that in Indian thought in general or in any particular Indian school of thought there is no parallel of the Greco-European conceptions just discussed : reason, sense experience, and relationship between them ; and science, philosophy and the relationship between the two. In India philosophy was never conceived of as rational in the sense non-empirical, nor was science philosophy dichotomy emphasised. One may, if one so wants, take this as an argument to show that there never existed any science in India. But this would amount to arguing in a circle. Thus even if it were true that the ancient philosophical speculation of the West has been from the beginning a matter of little or no consequence for science and is rendered wholly irrelevant today, the same may not be necessarily true about philosophical thoughts of another culture like the culture of India.

Contrary to how it may appear to many, our point is not merely polemical. There is a substantive reason why we want to emphasise this point. The important question involved here is what conception should one have of tradition or what attitude one should take about tradition in general as well as the tradition to which one was born. We have already indicated what attitude certain representative section of the working scientists of India today takes towards our traditional knowledge and ancient philosophical tradition. We have also indicated how they might have arrived at such an attitude or how they defend their attitude. Though we have no opportunity

here to defend it yet we would like to note here another possible conception of or attitude towards tradition. We also think that this alternative is more realistic and reasonable. We would like to quote in this connection what Jacques Maritian said on the occasion of reconstructing the old view of St. Thomas Aquinas. He said that we bear a sort of double obligation towards traditional wisdom. "We must defend the traditional wisdom and the continuity of the *Philosophia Perennis* against the prejudices of modern individualism in so far as it values, seeks and delights in novelty for its own sake, and is interested in a system of thought only in so far as it is a creation, the creation of a novel conception of the world. But equally we must show that this wisdom is eternally young and always inventive, and involve a fundamental need, inherent in its very being, to grow and renew itself. And so doing we must combat the prejudices of those who would fix it at a particular stage of its development and fail to understand its essentially progressive nature".[7]

This attitude to (Western) tradition or traditional knowledge or traditional wisdom is not so uncommon as we might have been led to believe. An eminent contemporary philosopher of America said, keeping the old philosophical tradition of India also in mind, we must "treat those who are great but dead as if they were great and living, as persons who have something to say to us now; and, further, that in order to do this we should do our best to 'introject' ourselves into their ways of thinking ; indeed to rethink their offerings as if it were ourselves who were the offerers ; and then, perhaps, it may turn out that it is ourselves". To men who have a cast of mind like this can state or find that tradition tells us many important things like the living great men or our own time.[8] We have also noted at the beginning Wheeler's view about the need for referring back to Presocratic thought today. Some contemporary Indian physicists are there who do not think that comparison between ancient thinking and modern science of nature is not worthwhile. They on the contrary quite justifiably want us to be cautious and suggest that "these comparisons and discovery of parallels between ancient thinking and modern physics must be understood properly".[9] Heisenberg for example has no illusion about the real strength of modern science and from where it is derived. He knows that appeal to controlled experiment provides firm foundation to modern science but he also says "all the same, some statement of ancient philosophy are rather near to those of modern science. This simply shows how far one can get by combining the ordinary experience of nature that we have without doing experiments with the untiring effort to get some logical order into this experience to understand it from general principles".[10] Perhaps nothing can be more accurate and nearer to truth about the character and relevance of Indian philosophical thinking about nature than these words of Heisenberg.

Even today many of the ideas of theoretical sciences do not get immediate experimental verification. There is reason to believe that some of the grand ideas will never receive such verification, for the cost of required experiment will be prohibitive. And there will be other practical and socio-political problems. Not only as a matter of fact but also as a matter of principle technology may lag behind the power of human mind — man's power of thinking or ratiocination. Sometimes again technology may give birth to new theory or revision in the earlier theories whether scientific or philosophical. Computer technology and researches in Artificial Intelligence have necessitated some revision in some of the philosophical arguments about the nature and functioning of mind. Development of quantum mechanics has necessitated the closer cooperation of scientists and philosophers.

What the philosophers were doing in the past is not always so different from what the scientists are doing today. Utilizing the available resources and equipment they were trying to bring about order in (or discovering meaning of) their experience of the world. In the process they developed certain branch of theoretical knowledge. There is no evidence that in India the theoreticians ever ignored or minimized the value of experience and observation. There was general agreement that reasoning should not be allowed to violate the verdict of valid observation, particularly when we are studying natural phenomena. There was no evidence to show that they were against the use of whatever machinery or equipment was available, though there was very little of them. Why they did not develop more effective and more powerful equipment ? Why is not there any record of discarded views — discarded as a result of new experimental findings or new contrary evidence ? Such questions are repeatedly asked. Some of the answers are well known and often repeated. But there is something to be said about the Indian mind — Indian perspective and orientation — and also about the orientation of the thought of the modern scholars who raise these questions. Before the emergence of modern scientific Europe (or a little earlier) theoretical pursuits never became so divorced from the immediate concerns of individual life and society; they never became solely or primarily institutionalized *academic* matter in the current sense of the term. So the ancient Indians usually did not show great interest in the pursuit of knowledge which was not actually needed — which could not be or need not be immediately used to serve some purpose other than the merely academic 'purpose' of understanding (knowledge for its own sake). Contrary to the belief that progress of knowledge was stalled in India because a divorce was effected, as a result of certain peculiar social institution like caste, between the head and the hand, between theory and practice, the knowledge or science was in the hands of the actual users who were the real custodian of knowledge. So a large body of knowledge was

transmitted orally in the continuing line of actual users who formed a long chain of supervisors and apprentices as well as teachers and students. As they changed their roles, and they were sure to get an opportunity to do that, knowledge was retained mainly in the form of memory and oral instructions (and not in the form of written records including books and articles in journal). There could not persist for any great length of time any doubt or illusion about the effectiveness of certain knowledge. For, immediate application would bring that out clearly, and in no time necessary revision, adjustment or even rejection would be carried out. So at any given time only the latest state of knowledge was available, usually no memory or record of earlier false moves or wrong views was retained.

It was very natural, under the circumstance, that people would express great confidence in the current views and state of knowledge. This should not be construed as their unjustified claim to finality or lack of readiness to make further advance even when the need for the same were felt. The fact is that they did not feel the need to go as far as modern science has developed. This is not to suggest that they could always reach as far as they wanted or that the Indian people wanted to develop their sciences exactly up to the point where we find it today. Anyway, different societies and cultures may attach different value to the pursuit of highly abstract theoretical knowledge. Even in modern scientific society of Europe objections are being raised against so much financial investment for experiments in some developing areas of highly abstract scientific theory. It is even being suspected sometimes, and not without some reason, that motivation behind developing some areas of knowledge in scientifically leading countries is not theoretical at all but practical or, to be more specific, political or military. It is very likely India did evolve some developed military technology including weaponry during the time of great wars. But such great wars were rare and political expansionism was not among the socially or politically valued goals. In course of time those technologies were abandoned and the relevant knowledge was forgotten due to long disuse.

Another point to note is that the Indian thinkers were not always or characteristically crazy after the absolute. Most of the time they were satisfied with the optimal. They were not too much bothered whether a certain view was absolutely certain or genuinely universal. They thought it enough, if nothing against it was known or there was no known contrary evidence at the time in question and if, besides, it served the purpose in hand. So there was no foundation in Indian way of life and thinking for going in great details to as large a length as 10^{26} metre (the length of the observable universe) or as small a length as 10^{-45} metre (quantum gravity).[11]

But this does not mean that they were any the poorer in their power of thinking or theoretical imagination. Long back they invented very large numbers for which they felt very definite need[12]; they also developed very accurate and minute measurements and weight systems for actual use in daily life.[13]

There is another evidence to show that Indian scholars of different schools were not predisposed to claiming finality and absolute truth of their respective view. But let us first recall the teaching of the history of modern European science. This history keeps faithful record of the gradual development of theories in any branch of science. Observations or experiments made at any time or the proofs offered or conclusions reached at a certain stage of the development of the branch of science in question or theories proposed at a period of time are all duly recorded. So it can be clearly made out if any earlier view has been revised or rejected in course of time and on the basis of new experience, experiment or evidence. There was further benefit. Some views neglected earlier could be restored or revived later without much difficulty when the right situation arises. If no record was maintained of earlier exercises in the matter then it would have to be discovered anew. Historians of science know that there are too many examples of such loss and recovery of insights and theories. This also strengthens the practice of not claiming finality in favour or against any theory. History shows us that it is always risky to reject or accept any theory finally, for the future is unknown and the science is progressing. How a particle theory would be judged on the basis of current state of knowledge 50 or 100 years hence nobody can judge today. Classical practice and habit was to model matter in terms of particles. Around 1960 an ad hoc alternative model was proposed; matter could now be modelled in terms of string.[14] (Superstrings theory may be traced further back to 1919 and to Theodore Calisaya[15]). The limitation of this model was known even before 1974 but in this year string theory ceased to be of interest even for modelling some of the strongly interacting particles. The string theory or the very idea of string model would have died if some small group of physicists did not continue to work hard with this model ignoring suggestion of many that they were merely wasting their time. But now, thanks to the work of those few determined researchers, string theory in its modern form - or superstrings theory — commands attention of a sizeable section of physicists.

The best way seems to be therefore to allow every theory to be pursued by its adherents if it has any. In future it may receive new justification or new criticism. Creative expression of this belief is the industry of history in general or history of science in particular. In some culture or society this belief can express itself in another form. This alternative expression may be found in the practice of allowing even the least popular theory or view, having insignificantly small number of adherents at

present, to exist and grow. Intellectual minority is not persecuted or socially boycotted. Intellectual majority is obliged to remember effectively the point of view of the minority. And it discharges this obligation by always stating and criticizing the point of view of the minority whenever its own view is to be offered. No Indian school of philosophy ignores the points of view of other schools irrespective of the number of adherents they have or how popular they are. There was intellectual majority but no intellectually dominant group in the classical period. Power group does not seem to be there though stature in the world of scholarship did count. Every school of Indian philosophy is found to consider seriously the view of every rival school.

Thus either we keep a faithful record of every idea, proof or theory or we allow every theory to be pursued by those whose taste it may suit, no matter how little may be their number. Intellectual minority of today may become the intellectual majority tomorrow. The fact that there exists so many rival schools of thought — which gives the impression that in philosophy no theory is ever refuted — is to be authentically understood as the commitment of the theoreticians to the value of not (fore) closing any debate finally. New justification — rational or empirical — may be found in favour of what is today the least favourable or prospective theory ; new criticism — based on rational or empirical ground — can shake the very foundation of the theory which is found to be most firmly established today. The maxim *Tarkāpratisthānāt,* formulated by Badarayana, is accepted by every Indian philosopher irrespective of which school he belonged to. This was made very easy for them because they were never affected by the craze for absolute truth. We need means of discovering truth, we need means of rationally defending or assessing our views whenever it is challenged. But this does not mean that at any given time we need the assurance that in principle it cannot be falsified or improved upon. However, we cannot reasonably adhere to a view if evidence against it is known or has been successfully shown to exist by the members of some rival school of thought.

I should not say that the situation is as congenial as that in the present European society. At least in the field of science the dominant group seems to make it very difficult for the minority group to live and work. "Scientists do not know the answers to puzzles like these which may call for radical rethinking. Indeed, howsoever objective they may call themselves, the practitioners of science tend to be reluctant to face new evidence that forces them to revise their ideas. Thus many of the puzzles are simply wished away".[16]

But still in those branches of European science which are more theoretical than experimental, debates do remain open. Professor Narlikar can write "Thus I disagree with those optimists who are confident that the 'end' of physics is at hand". In the

house or office of an astro-physicist arguments can continue indefinitely as to whether stedy state or big bang theory is the correct one. And if there is a parrot it may learn to talk "stady state or big bang", after repeatedly hearing these words ; people may even refer to the house or describe it as a place where stedy state and big bang being discussed all the time. Not that no progress is being made in the debate — perhaps new evidences are coming up and new arguments are discovered ; but as these are inconclusive many debate continues and old arguments are repeated along with new answers to new rejoinders. Same holds for the debate between a Bauddha and a Vedāntin or a Naiyāyika. No eminent Bauddha philosopher repeated the arguments which Nagrajuna offered against the philosophers of rival schools in his book *Vigrahavyāvartani*. But the debate and controversy between the Bauddha-s and their opponents have not been resolved. Every party seems to believe that more conclusive arguments may be discovered eventually in favour of its position. Thus the situation in the field of theoretical studies — whether in modern European science or in classical Indian philosophy — is nearly the same. Some debates remain open even if thinkers on one side are reduced to the status of intellectual minority for the time being. We are inclined to believe, however, that there is one point of difference. In modern societies — in modern Europe or modern India — intellectual minority suffers greater disadvantage than the intellectual minority in classical India. Sometimes the smallness of the number of members in the minority group is compensated by the stature of its members. The number of scholars who are pessimistic about physics reaching its end or the dream of grand unified theory (GUT) becoming true may be less than the number of optimists. But this minority has the distinction of having as member such celebrity as Feynman, Schwinger, Glashow and the like. These skeptics may accept the imminent end of physics if the end is defined operationally but not if it means that physicists will discover a GUT once and for all and which cannot in principle be revised or improved upon. But to say this is not to say final solution to no single question can be found or that the notion of final solution is inconsistent.

Earlier we dismissed the view that (S_1) or (S_3) holds or is true ; we thereby implied that, according to us, there obtains the situation (S_2). In other words, question as well as nature and method of inquiry are largely the same in science and philosophy. But if so, modern scientists are in a better and more advantageous position than the philosophers of the past to answer the question about creation of matter or of physical universe. Why then bother about ancient philosophical theories of matter? All that was good and right in those theories must have been documented, properly formulated, proved and incorporated in modern scientific theories of nature. Apart from historical curiosity there cannot be any justification for recalling or reviving

those old theories. Let historians study them if they like ; philosophers or scientists have no use of them any more.

We said earlier that it is precisely because science is so much similar to philosophy or, as some say, continuous with it, that we need to turn our attention occasionally to traditional thinking in course of the progress of science. As it has been formulated in the Indian tradition, progress of knowledge is like the movement of a lion. Lions have the habit of casting a hind look after every few forward steps they take. From this a maxim has been developed which is called *siṃhābolakana nyāya*. While pushing our theory forward we have been urged to turn to past state of knowledge to ascertain how much relative progress we have made. Those who do not do that tend to turn relative progress into absolute progress. There can be disagreement in detail as to how far back should we cast our look. But there cannot be any disagreement about the principle. It is especially desirable to look back to our past particularly when in course of our journey we seem to arrive at some blind alley, i.e., some puzzle to which no answer is found in the current body of knowledge or in the state of knowledge of immediate past. That is the time to search for every clue everywhere as has been suggested by Wheeler. Some may think that the current situation in physics warrants us to search every possible source for some clue or insight which may help or hasten the solution of some of the unsolved problems. One such problem is the search for fundamental or elementary particle or ultimate stuff of this world. Another problem which is related to the first is the ontological indeterminism of quantum mechanics discussed among many others by Wallace (See Wallace, W.A., "Elementarity and Reality in Particle Physics" etc., in Boston Studies in Philosophy of Science, Vol. II, D. Reidel Publishing Company, 1967). Search for elementary particle as well as grand unified theory, nicknamed the theory of Everything, have become fields of unresolved problem. Situation obtaining in these areas of science seems to be very much like the situation which, it is customary to think, always obtains in the field of philosophy. No experimental guarantee is there to support or sustain that we can combine particle physics with scientific cosmology or astro-physics. We are largely to depend on speculation or mathematical imagination. And if scientists over last three hundred years have become leaders in the field of experimental study, philosophers as well as traditional thinkers of the ancient time have mastered the art of speculation or ratiocination. What they discovered on the basis of ordinary unaided experience and power of thinking or reasoning may with profit be consulted. If philosophy and science were very different then perhaps discoveries in one of these fields would be irrelevant or of no consequence in the other.

There is one special reason why the present progress in science cannot be said to

have rendered the study of the traditional thinking of *India* unnecessary. Science philosophy distinction was neither so common nor so rigid in India. So philosophers were not averse to use observation and experiment. Indian philosophical thinking has never been purely speculative in the sense in which non-linguistic or non-analytic metaphysical philosophy or purely theoretical (having little or no practical bearing) discipline of knowledge of the West has been. This does not mean that what the Indian thinkers of the classical period had to say about the creation of matter or of elementary particle was not rational but empirical. They surely did not have the type of technology or, for the matter of that, instrument to test what they were saying and what even the highly developed instrument of modern science cannot verify. But at the same time they were always careful not to indulge in the free flight of imagination. For speculation or reasoning was required to be restricted within the limits of experience in that one was not allowed to say or believe something which was *anubhavabiruddha* i.e., contrary to ordinary experience. When so restricted speculation or thinking is expected to be nearer scientific truths and more acceptable to the scientists or can more easily be incorporated into the main stream of scientific knowledge. Anyway the requirement of not to be contradicted by ordinary experience is less stringent a requirement than the Kantian requirement that all scientific reasoning should amount to application of reasoning within the bounds of possible sense experience.

Another point should also be noted. Since science of a country is continuous with the philosophy of that country and present state of knowledge of a country is continuous with the traditional thinking of that country, modern science of Europe is not continuous with the traditional thinking of India. If such continuity does not exist there between traditional thinking of India and what science the modern Indians are practising then that science is not Indian science in certain important sense of the term. And some clue which European science may not find in the Greco-roman philosophical tradition with which it is continuous, may be found in the philosophical thinking of some school of Indian philosophy or other of the classical period. All who find something scientifically important in the traditional thinking of India — some great insights or ideas — are not necessarily wrong.[17]

II

In this second part we will present or reconstruct in brief outline a connected exposition, in English, of the theory of physical creation as we find it in the literature of a very old school of Indian philosophy. This school of thought, however, is not dead. It is still being studied, pursued and further developed. Generally speaking, the

logical and epistemological views of this school are more commonly and seriously studied than the scientific or cosmological views which we will discuss here.

This part of the paper is divided into three sections. The first section deals with certain preliminaries. The second section lists a number of tenets of the Indian school of thought in question relating to the problem of elementary particles and how they combine to bring the universe into existence. The third section elaborates on some of the listed propositions taken not separately but in groups.

II-1. The traditional thinking about physical creation which we will discuss here is essentially the theory of creation of the Indian school of thought known as Nyāya philosophy. The Nyāya philosophy is the totality of a number of connected views and thoughts on various matters which gradually took shape over many years. In the systematic form given to it by Gautama, Nyāya philosophy developed about two thousand years before modern European science developed. Around 10th or 11th century the Nyāya of the classical period yielded place to the new syncretic school known as Nyāya-Vaiśeṣika school. The emergence of this new school is one of the major events of the medieval period of the history of India's systematic quest for definitive knowledge. This syncretic school was formed by combining, in some sense, two sister systems of Indian thought — (classical) Nyāya and (classical) Vaiśeṣika — which were developing till then as parallel systems.

It has become a standard practice to refer to the views of the Nyāya-Vaiśeṣika (hereafter NV) school which we propose to discuss here as Indian atomism. This expression should not be over-interpreted to mean that modern science of Europe is rediscovering what was discovered long back by this old Indian school of thought. Nor should it be under-interpreted to rule out any relevance of it in the age of science on the ground that NV school of thought is or is known as a philosophical school of thought. For, as remarked earlier, there is not available in India any exact parallel of European conception of philosophy. The NV view under reference may better be taken as an example which shows, as Heisenberg put it, how far one can get by combining the ordinary experience of nature that we have, without doing experiments,[18] with the untiring effort to get some logical order into this experience to understand it from general principles.[19] The NV view in question begins with the example of matter of common experience — gross physical objects like an earthen pot, a piece of cloth, a mustard seed or a mountain. An NV thinker then notes two things about all these forms of physical substance. First, ordinary observation and experiment shows that all these things are destructible and secondly, though they all have finite dimension yet their dimensions are measurably and visibly different, some are larger than others. A foundational question was raised, wherefrom comes this

structure and nature of physical substances ? A resolute attempt at discovering answer to these questions by rigorous analytical thinking led them to the view we propose to discuss here. This is not however the only route to their theory of elementary particles and creation. Many lines of thinking converged in the discovery of these particles and the manner in which they combine. It is not so much important whether what NV thinkers of earlier days identified as the elementary particle are physically so. The important questions are : "Do we have any need for elementary particle as the building block of the physical universe ?", " Is the conception of such particles consistent enough to rule out a priori the possibility of future empirical falsification ?" and "Does this notion or the theory has explanatory value ?". From the point of view of the adherents of the NV view or theory of elementary particle, such particles are arrived at by sound reasoning from the observed nature of material bodies. Unlike the Bauddhas, they further think that imperceptibility of such particles is a contingent fact based on the limitations of available perceptual apparatus.[20] We also note that the scientists who are interested in physical theory asked similar questions about elementary particles — the building blocks of the universe. The NV theory is not, however, the only answer which India offered to the question "How the (material) universe was created ?". There was in the classical period another Indian school of thought according to which the ultimate physical stuff from which all the physical things that we see in the world have come is not a number of discrete material particles but a continuous physical substance.[21]

Be that as it may, we do not know if some Indian scientists of recent times have seriously studied the NV theory of elementary particles or, written books like Schroedinger's study of Greek atomism, namely, *Nature and The Greeks*. But Schroedinger's book may have been read by them and others. We would therefore like to enumerate some point of contrast between Greek View (Views) of elementary particle and NV position in the matter. Unlike the Greek thinkers Thales, Anaximander and Anaximenes, the thinkers of the NV school hold that there are four (or five) types — and not one type — of basic matter or elementary particle. Again the Greek thinkers held the view that the simple units of matter or the atoms were devoid of any quality and that different atoms were of different size(cf. paper cited against note 9). The NV thinkers hold the opposite view in these matters. In some other schools of Indian thought also elementary particles or *paramāṇu*-s are admitted. But the conceptions of elementary particle are different in different schools. To give one example, according to the Jaina School of thought all elementary particles have the same quality ; but according to the NV school each of the five (or five groups of) elementary constituents has a different quality. (See Sastri, Gaurinath, (ed.) Kiraṇāvalā (in Bengali), Part- I Introduction, p. 25).

A little more of history of atomism in European tradition will show that as in India so also in ancient Greece there was no rigid distinction between science and philosophy and different versions of atomism were available. Interesting point to note is that in the development of later scientific atomism these different versions made their contribution.

We have suggested above that the search for ultimate building block of the Universe is common to both science (at least in certain period of its development) and philosophy. The spirit of empirical study and awareness of the importance of experience and observation also were not denied by all traditional and philosophical thinking. But one may argue that modern science stands witness to the fact that both philosophical atomism and scientific atomism have run their course. The number of basic particles has increased from four during ancient time to 200 around 1960. Not only that, these particles are made up of each other. This situation led Heisenberg to declare in 1975 "The difference between elementary and composite particle has thus basically disappeared". But in the *Feynman Lectures on Physics* reprinted two years before his death Feynman wrote "If, in some cataclysm, all the scientific knowledge were to be destroyed, and only one sentence passed on to the next generations of creatures, what statement would contain the most information in the fewest words? I believe it is the *atomic hypothesis* (or the atomic *fact*, or whatever you wish to call it) that *all things are made of atoms — little particles that move around in perpetual motion, attracting each other when they are a little distance apart, but repelling upon being squeezed into one another.* In that one sentence, you will see, there is an *enormous* amount of information about the world, if just a little imagination and thinking are applied."[22] This remark was originally made in 1960s. Around the same time the concept of quark was discovered and there was hope that all the 200 odd elementary(!) particles could be found to be made up of a few quarks. But very soon the number of quarks started increasing ; "today the number of elementary entities at the level of quarks has slowly risen to some 40 or so ...". There is also "the fact that relativity and quantum theory put together make the question of constituents and substructure energy depedent."[23] All these may be taken to show that the search for elementary particle has lost its importance. But it is one thing to say that the ultimate stuff is not really particle but say wave or energy or string and it is another thing to say that the search for some ultimate stuff — atomic or subatomic — has lost all value. One may say, whatever other value it may have, the search for elementary stuff of the universe has little importance in *explaining* the origin of the universe. For the group of scientists who are especially concerned with the problem of the origin of the universe are not particle physicists but cosmologists. And cosmology and particle

physics are different specialized branches of physics. Those scientists who are fascinated by the idea, dream or prospect of GUTs are in favour of combining these two branches of physics.[24] But as we see it, unifying the forces of nature and combining particles are neither the same nor comparable. Secondly the idea or admission of uncreated or eternal particles as the building block of the universe does not seem to be compatible with at least that cosmological theory which is known as big bang. The very hot and dense matter which existed before or at the moment of the big explosion was one and destructible. Lastly in this picture of the universe the creation of space and time seem to be more easily comprehensible than the creation of tiny bits of matter. In short the atomic model of matter hardly seems to hold.[25]

Another important point may be noted. It is not true that atomism is the only philosophical theory of creation or even the only representative philosophical theory of creation. The Neoplatonists in the West and the Sāṃkhya (and Advaita Vedānta) philosophers of India advocate a distinct theory of creation. They 'deny' in fact atom as the ultimate constituent of the material universe. They differ from the atomists on more fundamental point also. They seem to reject the conceptual constraint that the explanans must have to be more minute or smaller. They agree that it has to be simpler. But being simpler and being smaller are not the same thing. They agree like the Nāiyāyika-s that the ultimate stuff should be uncreated but they think that what the Nāiyāyika-s call *bhūta* or elementary substance is not eternal but created. Unlike Nyāya these two philosophical schools also contend that the ultimate stuff is some single ubiquitous (continuous) matter or something which is numerically one (though not without internal complexity) infinite and material. Sāṃkhya philosophy admits a cosmic consciousness (but does not call it a God) ; it does not contribute anything towards the creation of the physical universe as an agent, even super natural one. Lastly emanation or transformation (of the primordial material) is more accurate an expression than creation to describe the process through which this observable physical universe — a variegated or non-uniform universe containing infinite variety of things having so many shapes and names — came into being.

There is one similarity between Nyāya and Sāṃkhya. Unlike the (advita) Vedānta, they are both realist. This needs a little explanation. It may be thought that at least NV school is a reductionist school or atomism is a form of reductionism. To take first a parallel case, the theory of superstrings. This theory is believed to be reductionist theory. One of the attractions of the most recent theory of superstrings in physics is said to consist in the fact that it has the potential of marking the successful end of a long search for fundamental particles of material universe. "... clearly another incentive for studying the subject derives from the fact that if superstrings theory does

eventually provide a quantitative explanation for all the particles and forces of nature, it will represent one of the greatest scientific triumphs in the history of mankind. Indeed, one might claim that it would be the culmination of reductionist science, because we would at last have *identified the smallest entities from which the world is built* and elucidated the fundamental principles on which the universe runs".[26] In the light of this remark NV theory of creation should be regarded as reductionistic.

It is undeniably true that the NV school of thought is a realist school of thought and that in one standard use of the term a realist is an anti-reductionist. So unlike the reductionists like the (Advita) Vedānta, NV is a realist school. And this realism is not incompatible with their atomism. To understand this we need to carefully distinguish between different senses of reduction. Cosmology — whether scientific or philosophical — considered as an explanatory theory, aims at providing unitary explanation of many in terms of one or a few. This is an unobjectionable form of reduction[27], in so far as there is no presumption that the one or the few from which the indefinite plurality of things — a universe full of real distinctions and multiplicity of things — come into being are *more* real (or *only* real) and the created universe is *less* real or unreal. According to NV thinkers the elementary (material) particles or constituents are no more real than the universe which is created out of them.

II-2. We propose to present NV theory of matter and physical creation by enumerating some important features of matter and its creation as these are understood by the philosophers of this syncretic school. We will then explain some of these interrelated features. It will make our understanding of these features or tenets easier if we note some contrasting tenets of rival schools of thinkers. These latter tenets will be enumerated against numbers with some negative number as subscript.

(P_1) Creation of the universe or the creation of the first ever effect which marks the beginning of the creation of the (physical) universe is not only an event but an action.

(P_{-1}) Creation of this universe is a mere event.[28]

(P_2) Creation is a real process (and not a reductive one).[29]

(P_{-2}) Creation of this universe is a reductive process.[30]

(P_3) Creation is a passage from the 'state' of non-being or non-existence to a state of being or existence.

Only a (so long) non-existent thing can be created.

(P_{-3}) Creation is a change of state which a thing existing all the time undergoes at certain moment of time. This type of creation may be called creation-T.[31]

(P_4) Creation of the cosmos is gradual.[32]

(P_5) Creation of any single gross material body of complexity greater than a binary particle or dyad is gradual.

(P_6) Indefinitely many creations had taken place in the past. Or, to put it differently, many universes had been created and destroyed in the past.[33]

(P_7) The created universe or *Jagat* is the sum total of all the created things (relative to that particular *jagat* or universe).[34]

(P_8) Creation of matter or material body is creation by contact i.e., conjunction of its constituent parts.[35]

(P_9) Conjunction which brings a 'gross' substance into being also sustains it till it is destroyed.[36]

(P_{10}) The expression "creation of the universe" is some times used to mean the starting point of the creation or the creation of the first ever created matter or physical substance.

Creation in this sense may with justification be regarded as instantaneous.[37]

(P_{11}) Cause of the destruction of a created substance is the destruction of the conjunction between its parts which generated it.

(P_{12}) The constituent parts of a created substance are the substances (of lower degree of complexity) which constitute it. These must be substances of the same single type, class or category.[38]

(P_{13}) The ultimate stuff of the physical universe must be more than one. Actually incredibly large number of discrete simple substances or elementary material particles constitute the stuff of the universe.[39]

(P_{-13}) The ultimate stuff of creation* is numerically one — a sort of a physical continuum, a continuous matter.[40]

(P_{14}) Each one of the many physical substances which are the building blocks of the physical creation is simple in the stronger sense.[41]

(P_{15}) Just as there is no physical thing simpler than *paramāṇu* so also there cannot be any dimension finer or smaller than the dimension of an atom. [42]

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* *On this theory creation and physical creation are one and the same. Even consciousness is physical in so far as it is created. Consciousness in the non-physical sense is eternal.*

(P_{16}) The ultimate elementary particles which are simple in the strong sense of the term are called *paramāṇu*(-s) or, roughly speaking, physical atom or elementary particle.

(P_{17}) *Paramāṇu*-s are eternal.

(P_{18}) There are five elementary substances or *bhūta*-s but only four kinds of physical atom or *(bhuta) paramāṇu*.

(P_{19}) Any one of the indefinite number of *paramāṇu*-s of the same single kind is distinguished from every other *paramāṇu* of that very kind not by the property which defines its 'class' but by an individuating property called *viśeṣa*.
There are as many *viśeṣa*-s as there are ultimate, indivisible and eternal substances any one of which belongs to a class of similar eternal substances like *paramāṇu*-s of the same kind.

(P_{20}) Two *Paramāṇu*-s belonging to one single kind or group alone can combine together to create a binary particle of the same element (or *bhūta*) kind.

(P_{21}) Physical bodies of different levels of complexities do not combine. [43]

(P_{22}) (A) The physical property of dimension can be both created and uncreated. (B) When the (created) physical dimension of certain (created) material body is created it is not always the sum of the dimensions of the constituting substances or parts.[44]

(P_{23}) Each of the 'infinite' number of *paramāṇu*-s of each of the four basic types of matter sometimes remain in isolation from every other *paramāṇu*. Sometimes again they remain in combination within the body of the dyad formed out of them. This dyad itself remains combined with another two dyads within the body of a triad produced out of the combination of three dyads (and so on).

(P_{24}) *Paramāṇu*-s cannot always remain combined.

(P_{25}) A certain pair of *paramāṇu*-s can remain combined or isolated for 'indeterminately' long or short time i.e., still conditions which are necessary to force them out of the current state of combination or isolation in which they are, occur.

(P_{26}) Duration of one single creation taken as a whole or one created *jagat* is fixed. During that entire stretch of time some (in fact most or all) *paramāṇu*-s will remain combined in the body of gross and created material substances.

(P_{27}) Only some created substances can be the constituent cause or material cause of another substance.

(P_{28}) Only some conjunction *(saṃyoga)* between substances can cause or produce a substance (of higher complexity).

(P_{29}) Like uncreated atoms some — but by no means all — created substances can also be cause of some other created substance, e.g., threads which cause the substance called (a piece of) cloth are themselves created.

Corollary : Only some *saṃyoga* or *saṃyoga* between some substances can be the cause of the production of some other substance.

(P_{30}) Each individual process of creation or the process of creation of any single substance is finite, it has a definite point when it begins and also a definite point when it ends.

(P_{-30}) The universe is in an ever changing state or process — it is perpetually in flux. Reality is a process and not a substantive thing.

(P_{31}) Substances are of four types : (i) those that are both *avayava* and *avayavin*. These are *bodies which are parts* (*avayava*-s) of some other substance and at the same time are *constituted by some substances as parts* (*avayavin*-s). These are finite substances ; (ii) those that are parts (*avayava*) of some substance but do not themselves have parts or are not *avayavin*. These are infinitesimal; and (iii) those that have parts (*avayavin*) but are not themselves parts (*avayava*) of any other created substance. These are called *antyāvayavin* ; and (iv) those which have no parts nor are they themselves parts of any other substance. These are neither *avayava* nor *avayavin*. Among the *bhūta*-s, only *ākāśa* is a substance of this kind.

(P_{32}) Creation of physical universe means creation of substance made up of elementary particles of one type or other. Such substances are called *bhautika* as distinct from the elementary particles known as *bhūta*. The elementary particles in the sense of *bhūta* are not created. *Mahābhūta*-s are however created.

(P_{33}) No created substance is made of elementary particles of more than one type of *bhūta*.

(P_{-33}) There are substances which are not only made up of elementary particles of more than one kind, but are made of all the five elements including the elements of each of the four kinds.

(P_{34}) There is no absolutely first creation.

(P_{35}) There are many universes, even many simultaneously existing universes.

(P_{36}) As creations and created universes are many so also many universes have in the past been destroyed. Destruction of a universe which precedes the origin and destruction of another universe is marked by the destruction of all created

substances including the particular binary particles which marked the beginning of that creation.

(P_{37}) Series of creation has no beginning but has an end. This end is marked by the destruction of all positive effects (*bhāva kārya*) including all the remaining moral virtues or vices acquired by the individuals in some past life spent in some previous creation or previously created physical universe.

(P_{38}) All (created) universes (including those which are yet to be created) presuppose the prior existence of only one kind of created thing and that is the moral virtues or vices. Rest of the factors that are presupposed are all eternal, neither produced nor destructible.

II.3 In the context of NV theory of physical creation cluster of concepts needs to be first clarified : atomism, matter, atom, physical or material creation and (if and in which sense there can be a) non-material creation.

II.3. i Indian Atomism. It should be noted first that though the expression "Indian Atomism" primarily refers to the Vaiśeṣika or Nyāya-Vaiśeṣika theory of creation of matter, it would be wrong to think that no other Indian school of thought admitted atom or that every school of thought which admitted atom, admitted it in the same sense of the term. Even within the same school different thinkers or section of thinkers held different views about the nature of atom. For a proper understanding of the NV atomism it would have been ideal if we could summarize the views of those who did not admit atom and those who admitted it but in somewhat different sense or senses. But that is not achievable within the limits of a paper. So we will concentrate primarily on the NV theory (of atomism) only.

As stated before, the expression "Indian Atomism" primarily refers to the NV theory of creation of matter or of the physical universe. The theory is so called because according to it the basic stuff of this universe or the ultimate building block is *paramāṇu* which is standardly translated into English as atom. It is, however, less misleading to translate the *Saṃskṛta* expression "*paramāṇu*" as elementary particle. We have discussed elsewhere[45] that it would be incorrect to translate the *Saṃskṛta* expression *dravya* as matter, for spiritual substance or soul substance is also *dravya*, Again just as *paramāṇu* is not correctly translatable as atom, so also *bhūta* cannot be accurately rendered into English as elementary particle. *Paramāṇu*-s (or more accurately *bhūta-paramāṇu-s*) are necessarily elementary particle. But at least one

bhūta (*dravya*) is there which is not elementary particle, or *paramāṇu* in the sense of ultimate, simple and *infinitely small* part of some created material body. For one of the five *bhūta-s* which the NV thinkers admit is *Ākāśa* — the substratum of *śabda* or sound. This *ākāśa* is numerically one and is infinite rather than infinitesimal. We shall return to the discussion of elementary particles and creation of matter a little later.

The Nyāya Vaiśeṣika theory in question is also known as *Paramāṇu - kāraṇa vāda* or a theory according to which the material cause of this (physical) universe is *Paramāṇu* or elementary particle. Now when we describe this theory as the theory of physical or material creation we do not mean to say that the NV thinkers have two theories of creation : one, the theory of physical creation and the other, the theory of spiritual creation. For, in the first place, they do not admit the creation of spirit or spiritual substance — no matter whether it is the divine soul of God or an ordinary soul of a human individual. And secondly, they hold that no spiritual substance is the constituent or inherence cause of any created substance. In short spiritual substances, since they are not created, do not have any cause and hence not any physical or material cause. These substances are also not themselves cause – physical, material, constituent or inherence cause - of any created substance.

II.3.ii Types of cause and types of creation. The NV thinkers, however , believe that there are only some effects which have material cause. To be considered as a material cause of an effect a thing must fulfil two conditions: it must be a material substance and must be an inherence cause of the effect of which it is the material cause. Only a created *substance* can have a material cause. The material substance which is the inherence cause of an effect is the material cause of that effect provided the effect itself is a created substance. Both a spiritual substance and a material substance can, however, be inherence cause of the effects — some created substance or created property of a substance — which, on being produced inhere in them. But only a material substance can be material cause of some other created material substance.So far the concept of inherence cause is wider than that of material cause.

By the expression "physical creation" or "(created) physical universe", we will understand here the totality of those effects which have material cause. The totality of other effects which do not have material cause may be referred to here as non-physical creation (even though these effects may be physical and external and they may have inherence cause). This non-physical creation presupposes physical cre-

ation. So there is a hierarchy or succession among physical and non-physical creations. Material or physical creation is more basic; and here we are primarily concerned with this type of creation. Material or physical universe is in this restricted sense, the totality of created substances and their material causes.Some of these material causes can themselves be the created material bodies having some other bodies as their material cause. The expression 'creation of physical universe' means the creation of the non-eternal physical bodies relative to a particular created universe (see below section II.3.v). The material causes are ultimately the elementary (material) particles which are themselves eternal. These are *paramāṇu-s* which are therefore the material cause of the physical creation or of (created) matter.

A spiritual substance can be an inherence cause but not a material cause. In other words no spiritual substance can be the (material or inherence) cause of any created *matter*, though it can be and is inherence cause of some (physical property like physical) quality or action. Another point may also be noted. The soul of every human individual is a spiritual substance, but thought or consciousness is not its essential quality. It can exist without any consciousness.[46] In some sense one can even say that according to the NV thinkers, a human soul, though it is a spiritual substance, can exist — and can also be thought of — independently of consciousness. But a human soul retains its distinction from a piece of stone or a log of wood even when it exists without consciousness. For consciousness as a quality exists, when it exists, in soul substance only. No other substance is either the actual or even the possible seat of consciousness. A spiritual substance is, on this view, conscious not in the sense that it is always the actual seat of consciousness ; such a substance is conscious in the sense that it is not the seat of absolute absence of consciousness (*caitanyātyantābhāvānadhikrantvam* or *jñānātyantābhāvānadhikaraṇatvam* is the definition of soul)[47]. Thus either we do not define a spiritual substance or soul (*ātmā*) in terms of consciousness (which is, at least, in case of human souls, a contingent quality) or we define it as 'not the seat of absolute absence of consciousness'. Similarly we either do not define a physical substance in terms of possession of externally perceivable physical quality (which is, at least, in case of a created material substance, a contingent attribute) or we define it as 'not the seat of absolute absence of externally perceivable property' (*vāhya-guṇādi-atyantābhāva-anadhikarana-dravyatvam*). Following is the reason why a created physical substance is admitted to possess only contingently all (created) physical properties or why such substances are believed to be the seat of physical qualities only in the weak sense of the term. An NV thinker may accept externality, if not extension, as the defining property (or one of the possible defining properties) of a material sub-

stance. The term externality is understood to mean perceivable by external sense organ. A (perceivable) physical substance itself or at least some qualities inhering in it must be perceivable by some external sense organ. But a created material substance stands to its own qualities and actions as inherence cause. As cause it must precede all its (created physical) properties at least by one moment. In that preceding moment it remains without any one of these properties. But even at that moment (when it is not the *actual* seat of any created property) the substance remains a *possible* seat of the external (created) property; it can never be said to be the seat of the absolute absence (i.e., absence not restricted to any particular time — past, present or future) of such property.

We need to say a little more about the dependence of the creation of other things (that is effects other than the created matter) on the creation of matter. These other things include (created) physical and mental (or, better still, external and internal) qualities and actions; by this we mean (created) qualities and actions of external or internal substances (i.e., roughly speaking, material or spiritual substances). Now so far as the created qualities and actions of physical or external substances are concerned, they are effects as well as properties of created (physical) matter. But unlike created matter these effects do not presuppose some matter as their *material* cause, even though they presuppose some created matter as their inherence cause. This shows that the creation of these effects, i.e., the created qualities and motions of physical substances are dependent (for their creation) on the creation of matter itself ; but the created qualities or motions of internal (or more narrowly, spiritual) substance cannot be said to be dependent on the creation of matter. For since they are not created properties of any physical substance the question of their dependence on the creation of physical substance does not arise. On the other hand no spiritual substance or internal substance is itself created. Here therefore are cases of production other than the creation of matter which however does not depend on the prior creation of matter.[48] How can it then be said that creation of effects other than (created) material substance depends on the creation of matter? The NV Thinkers have an answer. According to them an internal substance has created qualities or actions only when it is embodied, And this body is necessarily a created matter or created physical substance. Thus even these internal qualities and actions are dependent on the creation of some matter, though not on the creation of the substance of which they are the properties.

II.3.iii Creation of matter : Creation of matter in the wider sense means the creation of all non-eternal material substances as well as the created properties of

them. [We may even add to these the created properties of internal substances]. We shall here confine ourselves to the discussion of the creation of the physical bodies only. In this restricted sense the creation of physical universe means the creation of all the (non-eternal) material or external bodies including the living and non-living bodies. According to NV thinkers the explanation of the creation of matter or material bodies must be in terms of two things, certain fundamental stuff and certain principle according to which the created bodies may come into existence out of the primordial stuff. The NV thinkers hold, as we will see, elementary physical particles or *paramāṇu*-s constitute the fundamental stuff of the material universe and the principle of creation is certain form of combination or conjunction of the elementary particles.

(iiia). Existance and types of elementary particles : Following the usual style of the NV thinkers we begin with the example of a few objects of common experience: a piece of cloth, an earthen jar, a human body, a mustard seed and a mountain. All these are created material bodies and are physically as well as conceptually divisible. Further, they differ from one another in size. Another property which they share and which is important from our point of view is that they are not material cause — they themselves are not inherence cause of any other created material body. All these are quite apparent in the example of the piece of cloth. It is divisible into thereads out of which it is made. By putting together two or more clothes we cannot produce another body with its own identity in the way we can produce a piece of cloth — a unitary material body — by joining together, in a certain way, a finite number of threads. Just as by putting together, in some specific way, only certain material bodies we can create another distinct material body, so also only certain analysis or division of a created physical body of a sort, yields certain other created bodies out of which the analyzed body was created. Corresponding to every single created body there are two or more such bodies which created it. These latter bodies are physical constituents or material cause of the constituted body. The NV term for such constituted or created body is *avayavin* and for the constituting body it is *avayava*. Any and every part of a body or *avayavin* is not its *avayava* or constituting part. If we just tear a piece of cloth into a few shorter pieces we do not get the original piece of cloth necessarily analysed into its constituting bodies which can be regarded jointly as the material cause.

All external material bodies can first be divided into those that are *avayavin*-s or have proper parts or *avayava*-s and those that do not have *avayava*-s. No internal substance is an *avayavin* or composite body ; they are not analysable. So they

are not analysable into proper parts or *avayava*-s. Among the physical substances also, three infinite substances including *Kāla* (time) have no parts (and hence no proper parts either). Created substances therefore are of four types only — earth substance (*pārthiva-dravya*), water substance (*jaliya drāvya*), fire substance (*taijasa dravya*) and air substance (*vāyaviya dravya*). All the concrete physical bodies we have listed above are of the first variety or they are created earth substances. As created substance they have parts. We can argue both ways ; every created substance has parts and every substance that has parts is created.

Now the question is, "How many parts does a substance have?". The physical or earth bodies we have taken as our example are of unequal size. A mustard seed is so small and a mountain is so big. And one — though not the only — way of explaining their difference in size is to say that they are made out of different *number* of constituent parts. The mountain has many more proper parts or *avayava*-s than the mustard seed. One may think that two created physical substances may have the same number of parts yet one may be larger than the other because one or more of its parts is larger in size than any one of the parts of the other substance. But any proper part of a material body is itself a material body; and if it has a larger size then it is a larger body. Any such body is further divisible into smaller and smaller bodies at least till the bodies into which it is divisible is as small as the parts of the other body. Therefore we can always carry our physical (or conceptual) analysis of a material body up to the point when its parts will not be larger in size than the parts of another body. Ultimately therefore the difference in size is to be accounted for in terms of difference in the number of the ultimate constituent parts of the material bodies in question.[49]

Now both the mountain and the mustard seed are divisible or analysable material body. The question is are they finitely divisible or infinitely divisible. That into which a material body gets divided is its parts including *avayava*. (In the NV theory of creation only those parts of bodies matter which are *avayava*). Now if each of any two substances is infinitely divisible then each of them will have same number of parts i.e., infinite number of parts. In other words the number of their parts will not be different. How can they thenselves be different in size? So it is more reasonable and in conformity to our common experience to hold that (created) matter or material bodies are only finitely divisible. The point at which the process of (or finite number of stages of) division stops is known as elementary particle or *paramāṇu*. The process of division stops here because these *paramāṇu*-s are not further divisible; they do not have constituent parts or material cause. In fact they have no cause at all. For, any substance which has some other kind of cause (or

causal condition) must also have material cause. *Paramāṇu*-s therefore are uncreated. They are also non-destructible. And things which do not have either creation or destruction are called eternal (*nitya*).

But *paramāṇu*-s into which an earth substance like a mountain or a mustard seed can be ultimately analysed are called earth (*pṛthivī*) *paramāṇu* or elementery particle out of which all created earth susbstances are ultimately produced. All earth objects can therefore be found either in the created i.e., effect form or in the eternal form. In its eternal form every earth substance is an elementary particle (*paramāṇu*) of the kind earth (*pṛthivī*). Just as earth susbstances are either *pṛthivī paramāṇu* or (ultimately) made out of such *paramāṇu*-s so also all water substances can be classified into water (*jala*) *paramāṇu* or substances (ultimately) made out of such *paramāṇu*. Same is true about air or fire substances. Thus out of five fundamental kind of substances which are respectively the seats of five external sensible qualities like colour, smell etc. four are available in both eternal and created forms. *Ākāśa* is the only fundamental or elementary substance which is numerically one and is available only in the eternal form. It is the seat of the external sensible quality called sound (*śabda*).

While elements or fundamental kinds into which all the external or material substances can be grouped are five in number, there are only four kinds of elementary particles (*bhūta paramāṇu*-s) and only four kinds of created material things. There is no *ākāśa paramāṇu* or created *ākāśa* substance. It is an important tenet of the NV school that only elementary particles of the same single class or kind can combine in certain specific ways to produce grosser substances of that kind only. All created substances are ultimately produced by the elementary particles of one or the other of the four (element) kinds of *paramāṇu*-s. Thus any single substance is of one single element kind — or it belongs to the same element-kind to which its ultimate constituents belong. Basically therefore creation of matter or of the physical universe means creation of the substances of these four kinds.

(iiib). Types of material bodies : Let us take note of some other basic tenets of NV theory of creation of matter. For the facility of exposition let us confine to one single element class — *pṛthivī* or earth. So we have as examples of created earth matter, mountain etc. listed above. There are on the other hand elementary earth particles. These are two extreme sub-groups of earth matter. The elementary earth particles are eternal, partless and constituents (*avayava*) of structurally more complex earth matter, say binary earth particles. Things like mountain or mustard seed

is non-eternal and created, have parts and are not constituents or material cause of some higher order earth substance. So the *paramānu-s* are called final constituents (*antyāvayava-s*) and physical bodies like mountain are final product of the process of physical creation (*antyāvayavin-s*). Between these two types of external substance there is another group of physical things of which thread is an example. A thread is similar to a mountain in that it is created and has parts, i.e., divisible. But unlike the mountain, threads are not the final product, they in their turn cause, as material constituent, another material thing — the cloth — which is the final product. Like elementary paricles threads are constituent of some other created substance but unlike them threads have parts and are created. Thus we can arrange material substances hierarchically. At the bottom are the eternal elementary particles and at the top the maximally gross[50] created material bodies. In between there is a long range of all sorts of material things of all sorts of varying sizes or complexities. Binary particles (*dvyaṇuka*) stands immediately higher in the scale or just above the elementary particles. Right above binary particles are tertiary particles (*tryaṇuka*) and above them are material bodies made out of four tertiary particles. There are four such scales for four element class of substances. The upper end of every such scale is marked by the final product-substances. But there are qualitatively many final product-substances in every single element class. Most important of these are, in the class of earth substances, body of sentient creatures (*śarīra*) including the body of human beings, sense organs (*indriya*) and objects (*viṣaya*) from which such creature derive pleasure and pain.

II.3.iv The scope of a philosophical theory of creation. According to the NV thinkers the material universe or all the created matters — beginning with the least complex, the binary particles, and ending with most complex, a mountain or a developed organic body like the body of a human being — are not created all at once. They are created successively and at different stages of the development of the physical universe. Till the creation of human body the creation of man made things do not begin. The processes following which men produce material things like pieces of cloth, earthen wares or a very sophisticated machine are fairly known. Philosophical explanation ends with those created material bodies which must be available for man to produce further matter. Most important class of these material substances are natural objects, living bodies and sense organs. It is believed that some supernatural and infinitely wise and powerful being helps the creation of these things out of what is called gross elemental material (*mahābhūta-s*) like *mahā-vāyu* (great air as distinct from elementary air particles), *mahā-jala* (great water), *mahā-*

pṛthivī (great earth), and *mahā-teja* (great fire). These great and gross elements are created, exactly in the order in which we have enumerated them, out of eternal and elementary paricles of respective element classes. But creation of each type of gross elements is itself mediated by creation of intermediary bodies like binary particles, tertiary particles and so on.[51] We will discuss this point presently. But then we will introduce a simplifying assumption.

There are many substances like pots which are created in different regions of space simultaneously or at different periods of time. But our story of the production of each one of the many created substances which are brought into being by combining relatively simpler substances as parts has a definite begining. This story cannot be pushed back further than the creation of the dyads which marked the beginning of the given physical universe. It is therefore the formation of all the dyads which should mean the creation of a single physical universe. One single event of the creation of one single physical universe means the creation of all the substances that are brought into existence as a result of certain type of combination of parts which are simplest and uncreated substances. So far the dyads are the first ever things to be created and as such their creation marks the coming into existence of the physical universe in question. To put it otherwise, the dyads mark the first stage of the development of the given physical universe. The creation of all (created) substances other than these dyads take place only after the dyads have been produced or the creation has already started. So the creation of all effects after the creation of dyads are creation *in* or *within* this physical universe. The creation of a physical universe — as distinct from creations within a physical universe which presuppose the existence of this created universe — can therefore be taken to mean the creation of dyads. And when the NV thinkers say that this physical universe is the sum total of all created things (*kāryajāta*) [see (P_7) above], they actually mean the totality of dyads. The causal explanation or account of this physical universe primarily means the causal account of the formation of dyads (or up to the great elements, at the most) and not the production of jar and cloth and the like. Two distinct causes to which reference is made to explain these unique effect i.e., the formation of dyads are, first, the elementary particles as material (inherence) cause and second, the consciousness and will of God. God's will produces motion (which therefore is the first ever effect with which the creation of the physical universe begins) in the preexisting discrete and unrelated atoms. As a result of these movements elementary particles get conjoined and dyads are formed. Reference to none of these two causes is made in the causal account of any other effects. In other words, though God's consciousness is always there and hence always to be found

before any effect is produced yet God is not envisaged to will everything including a piece of cloth or a pot. But he did will to produce this universe and he brought into existence all the dyads — the formation of which marks the creation or beginning of the creation of this universe. Since the creation of the dyads, the evolution of the (physical) universe proceeds on physical principles till, at least, the bodies of the sentient creatures, particularly human beings are produced. Here onwards some of the created things owe their existence to the agency of sentient creatures, particularly men and still higher forms of conscious beings.

II.3.v. There are many universes (*brahmāṇda-s*) which may or may not exist simultaneously. It follows that many universes have been destroyed (after creation, of course) in the past and many universes may be created in future. But how many universes are or can be there or can be created or destroyed ? Which universe was created first and when — how long back? These questions are considered as meaningless or as admitting of no answer. It is meaningful to ask when a *particular* universe was created and how. But it makes no sense to ask when the *series* of universes began or which one was the first ever universe to be created. The series of universes has no beginning, though there is some strong moral or axiological argument to show that the series of creations would end in future — however distant that future may be. We shall not discuss this point in detail.

II.3.vi. Creation of matter is gradual. Here in this section we will not mean by gradual creation the successive creation of the four gross and great elements viz., air, water, earth and fire — in this order. We will simplify our account by supposing that creation of these four great elements do not mark four successive stages of the development of the physical universe. We will take all these great elements to have been created simultaneously ; and we will assume that dyads or binary particles of all the four element classes are produced simultaneously.

By gradual creation we then mean successive creation of material bodies, of different degrees of complexity, within any one single element class. Within any element class say earth, there are created material bodies of different structural complexities. An earth dyad is less complex than an earth tertiary particle. According to the NV thinkers creation of more and more complex material bodies follow the creation of simpler and simpler material bodies of the same element class.

We can divide the production of all created substances into two categories. First, the creation of such substances which come into existance as a result of the combination of some other *created* substances (the creation of which marks the

earlier stage of the creation and also the earlier stage or moment in the causal chain of creation through which the substances being created will be linked up with some definite number of definite binary particles); and second, creation of such substances which come into existance by the combination of some *uncreated* substances like elementary particles of one of the four types. The first type of creation presupposes the second type of creation.[52] Each single instance of the second kind of creation — the creation of the dyads or binary particles — marks the same stage, the very first stage, in the individual line of creation which begin with the creation of it. Again all dyads are formed at the same time.[53] And when the NV thinkers take the physical creation to mean the totality of all effects they mean, strictly speaking, the totality of all the dyads. For before these dyads there were no created substances and hence nothing that was created (in that universe). There were only uncreated elementary particles, other eternal substances and some other things which are not eternal but continuing from some previous creations. These last kind of things link up this created physical universe with a lomg and beginning less chain of creations.[54]

Now the question is why material bodies of different structural complexities must be created gradually? A part of this answer lies in the nature of the principle — as distinct from the primordial stuff — which the NV thinkers have chosen to explain creation. This principle is the principle of physical combination which is best exemplified in the relation of contact or conjunction, called *saṃyoga* in the NV literature. If one physical body moves towards another body which is for the moment stationary, or if two bodies move towards each other from different directions, then eventually the two bodies get conjoined with each other. According to the NV thinkers, in some such ways only two physical bodies can be realated by the relation of conjunction. The combination of parts of a substance which makes possible the production of the substance of which these are the parts is a special instance of this relation of *saṃyoga*. However, every instance of conjunction between two physical bodies cannot be taken as a case of effective or productive combination. Otherwise even the conjunction of an earthen jar with a piece of cloth — when we place a jar on the cloth — could give rise to another physical body. But for all that there are instances of conjunction both in the macro level and in the micro level which are productive i.e., productive of a new physical substance (*dravyārambhaka saṃyoga*). By conjoining threads a piece of cloth — a new physical body with identity of its own — is produced. A binary particle is produced as a result of the conjunction between two elementary particles or *paramāṇu*-s of the same element kind. Where a conjunction of parts creates a new body, the body produced is more than

just two parts in relation (*avayava-samghāta*). It is a single, unitary, newly produced and more complex substance (*avayavin*) in which parts or the relation are not separately identifible. To discover them we are to conduct conceptual or physical analysis or division. Where two bodies *A* and *B* are conjoined, but not by productive conjunction, as in the case of a jar on the cloth, we have experience of the form "the jar is on the cloth" or "the jar is conjoined with the cloth". Where the combination is productive we have the experience of the form "a cloth", "a speck of dust" or "a tertiary particle (*trasareṇu*)". *Avayava*-s can enter into productive combination, and thus can account for the emergence of a new substance of higher order of structural complexity.

The first ever physical body to be created — the simplest created body — is a dyad. It is produced by the effective combination of two elementary particles. In the next higher stage of the creation of physical body, the stuff or material available for productive combination are dyads. So what can be formed by the productive combination of three dyads is a tertiary material body which has three parts. At the next stage material available for effective combination are tertiary particles themselves. When four such particles are productively or effectively combined there is produced a four parts material body called *caturanuka*. It is in this way that material bodies of higher and higher complexities are produced.

One may ask why cannot a tertiary body or still more gross body be formed directly from six or more elementary particles? The NV philosophers have many intricate arguments and answers which we have no scope to discuss here. A few simple ones may be noted. If all physical bodies were made out of imperceptible elementary particles then when we break a tea cup by throwing it on the ground it will immediately disappear or become invisible. For it will get reduced into its parts which are on the view of the opponent invisible atoms. Thus any theory of the creation of gross matter out of elementary particles must also explain how from invisible stuff visible physical bodies emerge. The Bauddha atomists or the *Vaibhāsika-s* cannot explain this fact. They say visibility of a physical body depends on the greater number of its parts. Parts of all physical bodies are atoms, but if considerably large number of atoms are combined in a body then that body would become visible. NV thinkers are not convinced. First it is very difficult to determine how many atoms make a considerably large number. Secondly the visible magnitude of an observable physical body is not created simply by the *number* of parts. They say no created body can be perceptible unless it is created by combining parts which are themselves *avayavin*-s and unless the number of them is more than two. The least complex *avayavin* or least complex created body is dyad. So minimally

perceptible or first ever perceptible body is a body which is the product of the combination of 'smallest many' dyads. The word many means more than two. The word therefore means any number above two. The smallest such number is three. So according to the NV thinkers the least perceptible body is produced by combining three dyads. And hence it is a tertiary or three part body (and each part itself is an *avyavin*). Such a body being perceptible we should find an example of it among the visible objects of the world. NV thinkers find an example in the tiny speck of dust which is barely visible as floating in the air when we look at the shaft of light or sun rays entering the room through a tiny whole in the closed window. Well, why can we not say that all material bodies higher than binary particles are produced directly form these dyads? Why can we not say that a mustard seed and a mountain differ in that one has as parts many more number of dyads than the other. The NV thinkers will say that magnitude of physical bodies is not always a function of the *number* of — or how many — parts they respectively have. We cannot elaborate on it and many other intricate ideas of NV theory of physical creation. It is one of the most worked out theories and an example of how much one can achieve on the basis of ordinary experience and power of reasoning.

NOTES & REFERENCES :

* We are grateful to professor Chanchal Kumar Majumdar who read the first half of this paper and suggested a number of corrections and stylistic improvements. Otherwise the paper would have been far less readable.

1. Wheeler, A. H., "How Come The Quantum : Can Philosophy Help ?", in *Science Philosophy Interface*, (Vol.I.No.I), Calcutta 1996.
2. Problems of space, time, consciousness, number and the like are some such problems. Almost any problem about a traditional physical or mathematical concept can be so viewed.
3. Narlikar, J.V., "*Bhutas* : Some Reflections On Modern Scientific Concepts And Traditional Indian Thoughts" in *Prakrti : The Integral Vision Vol.4*, D. K. Printworld (P) Ltd., New Delhi, 1995.
4. Two points should be noted here. Not only philosophy and science but also mythology and history — even literature — belong to one single evolving system of human knowledge and experience of which they are different moments; they may even be viewed as so many different renditions of the vision or aspiration of a people which determine the cultural identity of it. So beneath the diverse forms of mythology, science, history, philosophy and so on there is a sort of

unity of vision or purpose which only gradually shapes and unfolds itself. The second point is that the way in which *purāna* and *itihāsa* are viewed in the Indian tradition is very much different than what these words are taken to signify by modern scholars — whether Indian or Western — who translate them as mythology. *Purāna* is not meant to be simply read or heard, taken literally and believed to be true, and cherished. Had it been so commentaries would not have been written on them confirming serious and sincere effort to understand or make sense of what are written in *purāna*-s and *itihāsa*-s.

5. Some scientists are visibly dismayed to witness the decline of philosophy into a mere linguistic exercise. see Hawking, *A Brief History of Time*, Bantam Books, New York, 1988, p. 185
6. Narlikar, op.cit. p.4. Our emphasis.
7. Quoted in Mukhopadhyay, P. K., *Indian Realism : A Rigorous Descriptive Metaphysics*, K P Bagchi & Co., Calcutta 1984, p.iv
8. Cf. Gandy, R. E., and Warner, R (eds.), in *Philosophical Grounds of Rationality*, Clarendon Press Oxford, 1986, p. 66
9. Mukunda, N., "Quantum Theory, Elementary particles: Limits to Divisibility" in Narlikar, J. (ed), *Prakrti*: *The Integral Vision*, Vol. 4., D.K. Printworld (P) Ltd., New Delhi, 1995, p.14
10. Quoted in Mukunda, N., op. cit. p.14
11. Narlikar, op.cit. p.2
12. Cf. Bose, D.M., Sen, S.N., and Subbaryappa, B.V., (eds), A *Concise History if Science In India*, Indian National Science Academy, New Delhi 1971, pp. 140-142
13. Rao, S.R., "Scientific Tradition in India" in Chattopadhyay, D. P., and Kumar, Ravinder (eds) *Science Philosophy and Culture in Historical Perspective*, New Delhi 1995 pp.32f
14. Davies, P. C. W., and Brown, J., (eds.) *Superstrings : a theory of Everything*, (Canto edition) Cambridge University Press, 1992/1995, pp. 67-69.
15. Crease, R. P., and Mann, Charles, C., *The Second Creation: Makers of the Revolution in Twentieth Century Physics*, Affiliated East-West Press Pvt. Ltd., 1987 (re-pnt. 1989), pp. 414-415
16. Narliker op. cit., p.3
17. See i) Boslough, John, *Stephen Hawking's Universe*, Aron Books, New York, 1989., pp 114-15 and
    ii) Mukhopadhyay, P. K., "Rationalism and Religion" in Mohapatra, P. K., et. all (eds.) *God, Time and Evil : The Swinburne Lectures*, P. G. Department of Philosophy, Utkal University, Bhubaneswar, India 1992, p-69.
18. Certainly experiment in modern sense could not be made. We have no evidence to say that the required technology was developed. Nor was perhaps enough fund or even interest was there. But even this does not necessarily make a theory devoid of scientific relevance. Similarly everybody does not think like Howard Georgi that recent scientific theories like string theory and other unified theories are not needed since they only apply to phenomena like the big bang that can never be approximated by experiment. see Crease & Mann, *The Second Creation* p. 416
19. Quoted by Mukunda, N., See Note no. 9 above.
20. Such imperceptibility is called *naimittika apratyakṣatva* as distinguished form *svābhāvika apratyakṣatva.*

21. According to the Sāṃkhya school of thought the ultimate stuff of the physical universe is one ubiquitous physical substance. Though continuous this can hardly be said to be smooth.
22. Feynman, R. P., Leighton, R. B., and Sands, M., The Feynman Lectures on Physics Vol I, Narosa Publishing House, New Delhi, reprint 1986/1995 pp. 2-3 (emphasis in the original)
23. Mukunda, N., op. cit. p. 13
24. "...paper demonstrated to physicists the compelling need to unite particle physics, the study of the smallest objects in existence, with cosmology, the study of the Universe as a whole." "...united with cosmology, elementary particle physics can present a picture of the history and evolution of the Universe even as it seeks to explain the ties among ordinary matter and forces." Crease and Mann, The Second Creation, p. 404, 405.
25. "...in the superstring theory you don't regard what now seem to be elementary particles as being composed of still smaller objects. One way people used to imagine that you might be able to get different sorts of electron-type particles was to take these sub-constituents and combine them together in different ways to get different electrons.
But that is not the way it works in the superstring. In superstring these different types of electron, as I said before, will correspond to the different holes which you could obtain when you were rolling up your imaginary newspaper." Davies and Brown (ed) *Superstrings* etc., 1988, 1995 reprint. p. 157
26. Davies, P. C. W., and Brown, J., (eds), *Superstrings : A Theory of Everything*, Cambridge University Press, 1988/1995, p. 69 (Emphasis is ours) and p. 227
27. see Mukhopadhyay, P. K., *Indian Realism*, K. P. Bagchi & Co., Calcutta, p. 252, 255
28. Though the idea of creation as merely an event was not unknown in India yet very few thinkers actually held this view. On the other hand though the NV school does not think that this universe is a mere event yet here we will discuss that part of the NV theory of physical universe where no essential or explicit reference is made to its character of having been created by some conscious agent.
29. For example according to the Advita Vedānta the observable physical universe (*dṛśya* or *jaḍa jagat*) is an appearance. Actually speaking this universe only appears to be there or to have come into existence. The conditions or processes which make this appearance possible can hardly be called itself a real process or at any rate it is not a real process of creation. There is a term for this type of 'creation' — *vivarta sṛṣṭi* or creation in appearance only. This account of creation is therefore reductionistic (objectionable) in the sense defined.
30. see note 29 above.
31. According to Sāṃkhy (and Advita Vedānta) there is no such thing as change from a state of non-existence to a state of existence. The real is always there. If this universe is real then it is eternal ; and an eternal thing cannot come to be created in the literal sense of the term. In the context of such a view creation can only mean change of form. Thus the real thing as well as their real states or features are existing all through. Creation is only transformation (or creation-T) from one real and existing state to another real or existing state. According to the theory creation-T, creation is change from some real state (other than the state of non-existence) to some other real state (other than the state of existence). It is therefore better to call creation-T — no matter whether it is a real or apparent process — emanation. (See Mukhopadhyay, P. K.,

"Unity and Multipliocity : Reflections on the Neoplatonic theme of Emanationism in the context of Indian Philodophy" (in press)

It should not however be thought that according to NV atomism also creation is really transformation : the atoms which are existing all the time change from one state — configuration or lack of it — into another state, a created substance is nothing but preexisting atoms in a new arrangement or organization. According to the NV thinkers this new organization is something more than the same stuff over once again (in a new arrangement). They think that the created substance is a single thing with its distinct identity (principle of individuation) and having more than one constituent. They have a term for it, *avayavin*. An *avayavin* is different from mere collection (of parts) called *avayavasamudāya* or *smghāta*.

32. This point needs a little clarification. Whether the creation of cosmos is gradual or not depends on what we understand by the word. But we can also fix the meaning of gradual creation independently and then examine whether the cosmos can be said to have been created gradually. A substance can be said to be created gradually if it has as its constituent parts substances each of which itself has been created earlier by combining its own constituent parts. Longer this process can be traced back in the past, more are the steps involved in the process of gradual creation of the complex material body in question. But cosmos is not a single substance of incredibly high degree of internal complexity decomposable into indefinite number of substances of lower and lower complexity till we reach the ultimate created constituents of it each of which is composed of just two substances none of which is internally complex. The cosmos is on the other hand the totality of substances of minimal internal or structural complexity, in other words the cosmos is the totality of all binary particles the constituent of each of which are two simple and uncreated substances or *paramāṇu-s* (roughly ultimate elementary particle of matter). Since between a binary particle and its constituent *paramāṇu-s* no other created substance is involved, the creation of a binary particle is not mediated by the creation of any other substance of lower complexity. There is no point to say that the creation of the binary particle is gradual. Its creation is rather instantaneous. Cosmos as the sumtotal of binary particles or the first ever substances or effects to be produced, should be said to be instantaneous.

    But if by cosmos we understand the totality of all the effects including all created substances of every degree of complexity and their qualities and actions then the creation of the cosmos can be said to be gradual. For all these effects are not produced simultaneously. For example the quality of a created substance presupposes earlier creation of the substance itself.

33. It is also believed that indefinitely many more such universes will be created (and destroyed) in future. Even so according to NV the series of creation is a finite series. There is such a thing as the last universe to be created in future. With its creation the process of creation which has no beginning will come to an end.

    Many intricate questions have been raised and debated in the philosophical schools of India. Some schools do not believe that the whole cosmos or the universe has been or could have been created. The idea of creation of cosmos as a whole is a figurative way of thinking and an extension of the concept of creation verified by ordinary objects of common experience. Literally speaking all creations are creation *within* this universe. There is no such thing as the creation *of* the universe where the universe is other than the totality of individual creations which take place within the universe. Universe is not a single substance or matter like atom or an earthen jar which can come into being at a given point of time. It is rather the totality of conditions common to each and every single creation or creation of every single thing.

The NV philosophers are hard put to distinguish their position in the matter from that of their sister realist school known as Mīmāṃsā which advocates the view sketched above. NV thinkers agree that the (physical) universe or cosmos is not one single substance like a jar. Again all the *individual* creations are creation within the universe. And if the universe is sum total of all the individual instances of creation or all the individual created things, then since all these cannot occur at the same time no literal sense can be given to the expression creation of the universe. What an NV philosopher means on final analysis by the expression 'creation of the universe' is the creation of the first ever substance or substances to be created and which marks the beginning of the gradual process of creation, in that particular universe, of indefinite number substances of different levels of complexity and their qualities and actions. And when they speak of the universe or *jagat* as the sum total of all created substances they should idealy mean sum total of *antyāvayavin*-s.

34. see the last paragraph of the note 33

35. The example given is that of a piece of cloth which is created out of the threads which are its parts combining the threads in a certain particular way or ways that a piece of cloth is produced. All creations are, however, not creations of material *substance*, nor all creations are therefore creation by contact or conjunction of parts. But we will discuss here only creation of matter or material substance.

36. We can as well say that the occurrence of that conjunction causes a material body in the next moment, the continuance of which (conjunction) explains the continuance of the substance which is so caused.

37. see note 32 above.

38. The corollary of it is that a substance which is as complex as the human body is not made up of all the five or five types of elements — it is not *pāncabhaūtika* — but of elements of one type only. According to NV thinkers human body is *ekabhaūtika*. Sāṃkhya philosophers hold that it is *pāncabhautika*. see Mukhopadhyay, P. K., "Bhutas : Some Interrelated Themes of Indian Cosmology" in Narlikar, J. V. (ed.) *Prakrti*, Vol. 4 D. K. Printworld (P) Ltd., New delhi 1995.

39. This tenet shows clearly that NV is a pluralistic system. One of the arguments which they offer in favour of this tenet is the argument from the observed sequence in which things in this world are created. Effects are produced in a sequence and not all at once. This fact cannot be explained if cause of everything is numerically one. cf. Udayanācārya, *Nyāyakusumānjaliḥ* verse no.1.1.7.

40. Sāṃkhya school of philosophy advocates this thesis. But for all that they are not materialist monist. They accept a second principle which is called *Puruṣa*.

41. In the ordinary sense a substance is simple means it cannot be analysed into more simple parts. In other words a partless (*niravayava*) substance (*dravya*) is a simple substance. But the Greek thinkers according to whom atoms are featureless and have no quality, take atoms to be simpler in a stronger sense. The NV thinkers do not believe that the *paramāṇu*-s are featureless. They however think that the dimension of an atom is not the cause of the larger dimension of the binary particle — or the substance of the higher complexity — which the *paramāṇu*-s produce as constituting cause. It is in this sense that we say they take atom to be simple in a stronger sense.

42. The substance which is created i.e., constituted by a gross body is grosser, and one created by a large body must be larger. But the dyad which is created by the smallest substance, atom, is not 'atomer' or 'more smallest'. Expressions like 'atomer' or 'smaller than atom' or 'smaller than the smallest' hardly make any sense.

43. One *paramāṇu* can combine with another *paramāṇu*. One binary particle can combine with another binary particle and one gross matter (a thread, say) can combine with another gross matter of the same level of complex structure (another thread).

44. There can be a substance which is created out of two smaller substances and yet the dimension of the created substance is not greater or larger than that of any one of the two constituting substances in the usual sense of the term. Normally a substance made up of two or three substances of equal size will have a dimension twice or thrice as large as any one of the two or three constituting substances. But there are exceptions. Division or distinction of substances into smaller and larger holds only when the bodies belong to one single range of dimension, or when the dimensions of different bodies in question constitute one range — the range of middle sized bodies. And dimensions belong to one range if one of them can be obtained by dividing or multiplying some other dimension. Magnitudes among which this relation of being obtainable by division or summation obtain constitute one range — range of middle sized substances.

    Physical substance according to NV thinkers can be of two different magnitudes or sizes — infinite and finite. The finite dimension is the dimension of middle sized bodies which are neither infinitely large (*vibhu*) nor infinitely small (*aṇu*).

    Unlike the infinite or infinitesimal, finite magnitude is not a single magnitude but a range of magnitudes within which physical bodies can be distinguished in relation to one another as larger or smaller. At the bottom of this range is the magnitude of the least large body or the least large magnitude. [We can even call it the smallest magnitude provided we do not confuse between atomic dimension with the smallest dimension. Atomic dimension does not belong to the range of middle size dimension at all. It is altogether a different type or kind of magnitude] The least large or the smallest within the range of finite magnitude is the substance, the magnitude of which is not the sum of the magnitude of its constituents.

    For if its magnitude were the sum of the magnitudes of its constituent parts then it would be larger than any one of its constituent parts and the constituent part would be the least large among the finite substances.

    On the other hand since the magnitude of any one of the constituent parts of the least large substance cannot be obtained by dividing the magnitude of that (constituted) substance by the number of the constituent parts, the magnitude of these parts do not belong to the same range to which the magnitude of the least large finite substance belongs. [Thus least finite magnitude is not a relative concept but an absolute one]

    Again the largest magnitude within the range of finite magnitudes is one which cannot be obtained by dividing the magnitude of still larger body. This happens when certain finite body — which itself has constituent parts — is not a constituent of another substance. These are *antyāvayavin*. The size of an *antyāvayavin* may be as large as the cosmos or as small as a mustard seed. But no two mustard seeds combine to produce a larger mustard seed. Thus collection of mustard

seeds will constitute a heap or mere collection but will not lead up to the production of a new substance of greater magnitude.

II

Substances which are middle sized — that is triad to largest (again largest in the technical sense of *antyāvayavin*) among the middle sized substances — are all created. Any substance of this middle order has a dimension as large as the sum of the dimensions of constituting substances each of which is of the same order of complexity within the kind or range of dimension in question that is *mahat*. In other words when two *mahat* substances of a certain order combine to create another substance, the created one is a larger substance within the same class of middle sized substances and is called *mahattara*. However large a substance may be if it is created out of finite substances then it itself will remain finite — a larger (or largest) finite substance; it can never become a substance of any other of the two kinds distinguished in terms of dimension — infinite or infinitesimal.

A substance, however small it may be, it cannot be atomic in dimension if it is made out of two or more constituting substances each of which is non-atomic or middle sized. Similarly, however, large a middle sized substance may be it can never become infinite, if it is made out of substances of finite magnitude. Thus division of substances into larger (*mahattara*) and large (*mahat*) holds only within the range of finite substances or substances having finite magnitude. Within this range if two large bodies combine to produce a third body then the third body will be larger and its dimension can be measured as the sum of the dimension of each of the few smaller substances of the same order of large magnitude (i.e., in order of *mahat*) which are its constituent parts. We cannot however say that if two substances fall within the range of infinitely small, and if they combine to produce a third body, then the magnitude will be 'larger' in the range of atomic dimension. For larger makes no sense in that range or we could distinguish substances which fall within the range of atomic substances as atomic-er atomic-est (like large - larger- largest). In other words finite is no single magnitude it is a range of magnitude within which the magnitude of any substance is the sum of the magnitudes of the substances which are its immediate constituents. A substance constituted by four triads (*trasarēṇu*) will have a dimension of the higher magnitude called *caturaṇu* which is the sum of the magnitudes of each one of the four *trasareṇu*-s. Thus least large substance within the range of finite magnitude is made out of three pairs of *paramāṇu*-s and next higher in the hierarchy is a substance which has four triads as constituents.

We can also reverse the rule. If a substance has any dimension which is within the range of finite magnitude then if it is not the least among the finite magnitudes (in ordinary sense) then it is the sum of the magnitudes of its constituent large substances..

45. Mukhopadhyay, P. K., "Bhuta-s" etc. (See Note 38)

46. The NV conceptions of substance, matter and spirit are different from those of Descartes.

47. It seems that the dominating group of Naiyāyika-s at Sampurnananda Sanskrit University, Vārānasi, is inclined nowdays to hold that human soul is conscious in the stronger sense which makes consciousness its essential quality. But this is known in the tradition of NV as the opin-

ion of a section of Naiyāyika-s who are said to be the followers of Bhāsarvajna — a Naiyāyika of the middle age.

48. Similar instances are there. Take any created quality of any infinite substance like *ākasā* or *dik* the problem here is more difficult to answer than in the case of created properties of internal substances.

49. According to NV thinkers (created) size or magnitude of a created body (and hence size difference between any two such bodies) can be caused or explained in any one of the three different ways. If the constituent bodies are themselves gross i.e. of the size of a tertiary particle or still higher size particle, then the magnitude of these constituent bodies causes the magnitude of the created grosser body. (see Durgadhar jha (ed). *Prasastapādabhāsyam* with *Nyāyakandali*, Varanaseya Sanskrita Visvavidyalaya, Varanasi, 1963, p.324). The magnitude of the binary particle or of the tertiary particle is caused by the number of the constituent parts. A binary particle has only two parts — two atoms, whereas a tertiary particle has three constituent parts — three binary particles or *dyṇuka*. Now if we take one iron bar weighing ten kilograms and one bagful of cotton also weighing ten kilograms, the cotton will look much larger and occupy greater amount of space. Here the cause of the objective and visibly different magnitude of the bagful of cotton is due to the fact called *pracaya* — loosely connected parts (ibid p.322 & 325). See also Bhattacharya, Gopinath, Essays In Analytical Philosophy, Sanskrit Pustak Bhandar Calcutta, chap. 4.

50. Grossest should not be confused with the largest. Both a mountain and a mustard seed are grossest form of material (earth) substance. Here grossest means not the constituent of any other substance i.e., *antyāvayavin*. *Mahabhuta-s* are also not *antyāvayvin*. But it is very difficult to place them in the hierarcy of three kinds of bodies — elementary or samallest bodies, middle sized bodies which combine to produce structurally higher types of bodies and the maximally gross body which are not proper parts of any other (still more gross) body.

51. Roughly speaking God Maheśvara initiates the process of creation of the physical universe by desiring to create this universe. Eventually eternal elementary particles of each of the four classes get conjoined and there are produced in succession binary particles, tertiary particles.....and four great elements. Then there is produced what may be called a very hot and dense body called golden egg. Though it is essentially made out of great fire element (which is produced ultimately by elementary fire particles or *teja paramāṇu*) yet great earth element is also somehow present in it. In that golden egg are produced this physical cosmos along with god Brahmā. Brahmā — the first ever created conscious being — is in his turn entrusted with the creation of different grades of conscious beings up to human beings (that is their body) and other sentient beings of lower order. Thus from this point of view there are three creations distinguishable in terms of the agency of three different grades of agents. First the eternal supernatural agent God creates up to great elements and Brahmā. In the next stage Brahmā creates many types of beings including beings with biological bodies — lower animals and men. Here ends the creation of the natural order which falls within the purview of the philosophical theory of physical creation. (see Durgadhar Jha (ed) *Prasastapādahāṣyam* with *Nyāyakandalī*, pp.127-31). Then follows the world of things created by men.

52. Earlier we discussed that the creation of non-eternal properties like quality and motion preseupposes the creation of material bodies. Here we are saying that the creation of certain

type of material bodies depend on the prior creation of some other type of material body. This chain of creations or created substances end, in one direction, when we arrive at those material bodies which no longer presuppose the earlier creation of any other material body.

53. This is not in conformity with the standard texts of NV literature. But in these literature we do not always find elaborate, clear or convincing argument why all dyads including dyads of all the four element types cannot be created simultaneously. Their simultaneous creation seems to us to be logically more economical a position. But we do not want to argue this point here. Hence it may for the present be taken as a provisional assumption made on practical or pragmatic consideration of simplicity of exposition. We said so in the section on the scope of philosophical theory of creation.

54. See Mukhopadhyay, P. K., "In Search of the Real Issue", in Mukhopadhyay P. K. and Singh, Navjyoti, (eds) *Sṛṣṭi and it Philosophical Entailments*, Prasthanmimamsa series no. 2, New Delhi, 1990.

SCIENCE PHILOSOPHY INTERFACE
VOL. 1 JULY-DECEMBER, 1996 NO. 2

REVIEW

ASTRONOMY IN INDIA*
— A perspective

by Rajesh Kochhar and Jayant Narlikar

Sometimes, a book does, really, deserve worth mentioning, particularly, if it comes from illustrious authors. The present book is of this type. The development of astronomy that had become a cultural tradition in India from the time immemorial and presently is a branch of modern science in its own right has properly been described here in the Indian context. There is no doubt that this book is informative in kind. The subject matter of it is subdivided into four different aspects described in four chapters.

In the first chapter the Indian Astronomy from Vedic to Siddhantic period has been discussed, although in brief, but it contains adequate information in this regard. Then the discussions proceed naturally towards the period of British presence in India, when European astronomical observational techniques began to function here simultaneously with Siddhantic astronomy, though modified to some extent by observational data of British Indian observatories and also by original researcher like Samanta Chandrasekhara Simbha of Orissa. Another medieval astronomy is Zij astronomy which made its debut under the patronage of King Ferozshah Tughlag. A short resume of this astronomy is given there. Also this chapter contains a list of Sanskrit texts on Siddhantas, Karanas and instruments. Then, the early observatories under the patronage of British rule which may be regarded as the beginning of modern Indian astronomy both positional and physical have been described in details. In fact, in the advent of physical astronomy in India considerable contributions came from Indian scientists. Prof. M. N. Saha's theory of high temperature ionization laid

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* *Indian National Science Academy, New Delhi, 1995 Price : Rs. 90.00 US $10 10. pp.86, Paperback.*

the foundation of modern astrophysics. Other Indian contributions mostly before India's independence and from university sector were significant and are described in this chapter.

In the second chapter the authors made an informative account of astronomical facilities that are available in India in different branches of observational and theoretical astronomy. These include optical, radio, space and gamma-ray astronomies and as the informations are quite exhaustive it will be very useful for interested researchers and students.

The third chapter provides a concise account of research activities in different institutions, observatories and universities of India. The wide range of Indian research activities includes solar physics, stellar structure, galaxy formation, large-scale structure of the universe, high energy astrophysics, quantum gravity, general relativity etc. The universities, observatories and institutions where research workers are engaged in research in these fields are mentioned there. Of course, the eastern region of India has not been properly reflected in this regard apart from mentioning the achievements of earlier eminent scientists like Saha, Sen, Raychaudhuri and others, although it is not a fact that in recent times this part of India does not participate in research activities of modern astronomy and astrophysics.

The last chapter contains informations about astronomical societies and academies engaged in promoting serious research as well as popularization of the subject among the people. The book also contains a list of institutions, societies etc. though it is not a complete one. Several good photographs on observatories, instruments, texts, manuscripts etc. and a painted sketch of Lilabati, that are cited in this book are also of worth mentioning. On the whole this book should be considered as an important documentation in regards to astronomy in India and also a 'must' for all libraries. It should also get the attention of a wide spectrum of readers.

S. S. De

SCIENCE PHILOSOPHY INTERFACE
VOL. 1 JULY-DECEMBER, 1996 NO. 2

REVIEW

FROM INTER-DISCIPLINARY TO CROSS-CULTURAL STUDIES

P. K. Mukhopadhyay

Inter disciplinary research can be conducted within the confines of any one of the "Two Cultures" as described by C. P. Snow or it may cross the boundaries that divide these two cultures. In the latter case the interdisciplinary work will be an instance or subject of cross-cultural studies. But paradoxically enough this cross cultural character has been achieved by further subdividing a single sub-culture — the theoretical culture — into two, sciences and humanities.

For different reasons people find it important to promote interdisciplinary studies. Members of PRASTHĀNAMĪMĀMSĀ, a national research network of India think that such studies alone can breathe life into the academic culture rendered artificial and lifeless by systemic insularity caused by progressive fragmentation of knowledge and information being perpetrated too long in the name of (over) specialization. "... divisions and subdivisions of an academic discipline tend to discourage effective communication across them" (Majumdar, C. K., "Two Cultures Revisited" — being the review of *The Two Cultures (1959) and The Two Cultures : A Second Look* (1963) by C. P. Snow — published in The Statesman August 6, 1994).

When the experts of the narrowly delineated areas of knowledge are confined to very small groups then the logic of survival leads the members of such groups to forge a solidarity which is not always based only on the consideration of real merit of the work of the fellow workers. The solution which has been suggested is that around every specialized branch of knowledge there should develop a community of informed amateur consisting of people who are experts in their respective fields of study but at the same time take living interest in the neighboring areas of knowledge. Members of such community alone can offer honest criticism and worthy appreciation which are so essential for the healthy growth of any branch of knowledge.

There are a number of interdisciplinary research journals covering sciences and philosophy like the present one lunched by CCASSP. *The Dialogue and Humanism : A Universalist Quarterly* first published by Warsaw University in 1991 is another such journal which has been seeking to promote dialogue across the boundaries of different branches of humanities and sciences.

There are others who think that interdisciplinary studies can be viewed with or within a broader perspective of cross-cultural conversation. For intellectual culture is one of the important subcultures within the comprehensive culture of any country. If we do not keep in view the problems and prospect of cross-cultural conversation then interdisciplinary studies may turn out to be another instance of either universalist discourse or ethnocentric discourse — both of which, paradoxically enough, can in different ways, strengthen rather than eradicate misunderstanding among cultures of the world. Dr. Anindita Balslev is one among the few who is acutely aware of this danger and at the same time arguing with sound optimism, through her writings, that cross-cultural conversation based on authentic information is both possible and necessary.

Encounter between cultures is no new phenomenon in the history of human civilisation. But earlier encounters necessitated by travels, by trade and commerce or even by political invasion have never been so extensive or inevitable as they are now in this technological age when both spatial and temporal distances have been "killed" by the new revolutionary inventions in technology. Though culture studies — at least in the form of dialogue between cultures, if not in the form of cross cultural conversation — is not as old a phenomenon as encounter between cultures yet it has been there quite for some time. But only very recently professional philosophers have started taking serious interest in cross cultural study; it is yet to become, if ever it does, one among the core areas of philosophical teaching and research. From this point of view correspondences between two philosophers deserve serious attention. The book under review contains six letters — three each by Dr. Anindita Niyogi Balslev and Professor Richard Rorty. It has been published by Indian Institute of Advanced Study, Simla, in the form of a book bearing the title *Cultural Otherness* [1].

It is not primarily across "the two cultures" of Snow that Dr. Balslev wants authentic conversation to begin. She has in mind such different cultures as the

1 Though it is not a recent publication yet we have chosen this work, from among the books received for publication, for review because it has a great relevance for the ideal and activity of CCASSP. The present article is more than a conventional review article. — P. B., Editor.

Western and Indian. But these two sets of 'two cultures' each, may not be unrelated. Occidental and Oriental cultures which existed there from a long past got a new meaning and sharpness in the age which is marked by the new division of cultures highlighted in the phrase coined by Snow. For "At the end of World War II, the European empires disappeared and many countries in Asia and Africa became independent. Each country was confronted with the problem of two cultures, the Western culture and its own" (Majumdar, C. K., op. cit.).

But though encounter between cultures had been there for long yet factors like lack of authentic information, cultural bias and so on led to characterize the difference between the Western and Indian (Asian) cultures as essentially a difference between rational or scientific culture on the one hand and non-scientific (literary or religious) culture on the other (see Mukhopadhyay P. K., "History of Science and Two Metamorphoses of Mind", in Chattopadhyay, D. P. And Kumar R., (eds.) *Science Philosophy and Culture : Multi-disciplinary Explorations, part I*, PHISPC, New Delhi 1996). Even today in the age of ethnosciences many Indians are against categorizing science as Indian or Western on the ground that science is universal. But both Indian and Western scholars have been repeatedly raising and discussing the question why modern science (which has become equivalent for science) did not develop in India and in any Asian country. As back as in 1930 Professor Krishna Chandra Bhattacharya warned Indian students against the danger of such universalist discourse without denying some truth in the claim of universality in favour of science (see his "Svaraj in Ideas" in Indian *Philosophical Quarterly*, Vol. XI, No. 4 October-December 1984). And in 1990 Balslev asks Rorty, who favours and practises ethnocentrism (may be of a mild variety), "How do we recognise art, music or literature in other cultures ? If there is no question of making any special effort in obtaining any inter-cultural consensus about these which presupposes a trans-cultural 'we', why treat philosophy as an expression which is restricted to any single culture [the Greek or the Western] ?" (p.40) She continues, "It is indeed interesting that the intellectuals in the West usually do not seem to have much trouble in discerning Hindu mathematics as mathematics, astronomy as astronomy or grammar as grammar or even poetry as poetry, why, I wonder, it is especially difficult to recognise any cross cultural experience and expression as philosophy" (p.41). She asks this question not without reason. She knows not only that many Indian and Western philosophers are there who do not believe that India ever developed such a discipline of knowledge as philosophy but she also knows that "Some of the attempts to relate to the East on the part of the Western philosophers have precisely therefore been of the genre where the East is seen as

... bankrupt so far as philosophy is concerned"(8). Rorty himself suspects that difference between him and balslev is perhaps most intractable when it comes to the question of philosophy — its nature and efficacy : "It is as if we had utterly different pictures of what sort of thing philosophy is" (80). For Rorty perhaps the hope of inter-cultural conversation (or even dialogue) rests solely in the production of works which it will be very difficult to categorise as Eastern or Western. And Balslev loses no time to put this question to Rorty : "The fact that it is difficult to see whether a work is 'Western or Eastern' I wonder how you accommodate that in your ethnocentric frame, and what it implies for what has happened to the sense of ethnic identity of the author. If you grant that boundaries can be crossed, how far are we — in theory — from some form of universalism?" (66). It seems true about any recent work that either the work will be unclassifiable or it will be classified as Western (in essence and spirit) — particularly if it is a work of any genuine merit and belongs to the area of science or philosophy. So whether we are operating within ethnocentrism or universalism, the logic is clear — either we (the Western people) win or you (the Eastern people) lose. Unless a cross-cultural conversation is going to benefit the West in its exercise of hegemony it is unlikely to catch their imagination. So it is possible for Rorty to dream an ideal cosmopolitan global society but the hope for such a future lies in the Europeanization of the globe (67). It cannot be unknown to Rorty that "Many in the 'third world' look forward to social change yet do not wish it to be in the direction of Westernization"(68). But he does not explain why he thinks this hope to be unfounded.

We would like to remind Balslev — what she already knows — that Rorty is not the representative of all sections of western (American) intellectuals. To cite one example only, Paul Grice, who certainly does not command less attention and admiration as a philosopher, is so honestly confident and vocal about longitudinal and latitudinal unity of philosophy. And he says "....often substantially similar positions are propounded at vastly differing dates. Those who are in a position to know assure me that similar correspondences are to some degree detectable across the barriers which separate one philosophical culture from another, for example between Western European and Indian philosophy" (Grandy, R. E., and Warner, R., (eds) *Philosophical Grounds of Rationality,* Clarendon Press, Oxford, 1986 pp. 65-66). In view of such examples it does not seem to carry conviction when Rorty remarks "I am quite willing to agree that Husserl was, as I am, too ignorant of Indian texts to know whether they are classifiable with the help of terms like 'epistemology', 'metaphysics' or 'logic' " (51). The second point which we wish to note is that the practical difficulties which Rorty has pointed out in the matter of changing philosophy

curricula to facilitate students to be acquainted with philosophical traditions of different cultures (pp.75-77) are very genuine and serious. The same holds about what he says regarding the efficacy of philosophy to transform society in our times. Despite the apparent flippancy of many of his remarks the strength of conviction, honesty of expression and deep concern make correspondences of Rorty extremely valuable and deeply enjoyable.

But Balslev seems to think rightly that Rorty is "somewhat underemphasizing" the pressing need of today — understanding the cultural other based on objective information. This has turned out to be a great practical need today when technological innovation has imposed on us — for good or bad — such closeness and has made so much information so easily accessible. The second point is that Rorty is underemphasizing the importance or role of a philosopher including, as Dr. Balslev has been able to make Rorty clearly say (55), a good pragmatist, in ensuring global community. In the book under review Dr. Balslev initiates, with profound seriousness and great sense of value, the discussion "concerning ... Cultural Otherness and Philosophy, focussing especially on the encounter between India and the West." It is not the love of the exotic or desire for self-enlargement which leads Dr. Balslev to raise these questions. She thinks that through cross-cultural conversation a certain tradition can achieve deeper self understanding besides contributing to the emergence of global community. Dr. Balslev is not prone to essentialize — a tendency which Rorty as a good pragmatist decries — human culture as such or the Western or Indian culture and she even admits important differences within any single cultural and between any two cultures. But from this one should not argue that cross-cultural conversation is impossible. Dr. Balslev is not as sure as Rorty seems to be that philosophers who are good at discoursing in the abstract cannot be hoped to contribute to transforming the present societies into a global society. This can be done by novelists, journalists and politicians. One may suspect that Rorty is here essentializing these vocations.

SCIENCE PHILOSOPHY INTERFACE
VOL. 1 JULY-DECEMBER, 1996 NO. 2

DISCUSSION & OPINION

MODEL THEORY & HINDU PHILOSOPHY

Sangeeta Mukhopadhyay

Debashree Dutta

I

Shri R. S. Kaushal's paper "Modelling in Science and Religion : From the Point of View of Ancient Hindu Philosophy" (published in Vol. I No. 1 of the Journal *Science Philosophy Interface* raises too many questions.

Does Ancient Hindu Philosophy have anything to say about Modelling in Science and Religion? Shri Kaushal thinks (unquestioningly) it has. The pertinent questions are the following.

(1) What is the ground for his conviction ?

(2) What does he mean by model in general ?

(2_1) What does he mean by a model in the context of science ?

(2_{11}) What does he mean by a model in the context of religion ?

(3) What does he hope to arrive at as a result of this study ?

II

One of the major things which Shri Kaushal has to say with reference to the question (3) above is this. (A) Advance in science and technology has brought men living in different parts of the globe so close in space and time that search for norms which will be valid for whole mankind has started. Such norms can be derived only from "the basics of all religions" or from what is the root of Hinduism viz., "vedic

philosophy" or "vedic knowledge". The basis for Kaushal's conviction lies in the fact or his belief that "Vedic knowledge appears to be free from modelling as far as the descriptions of nature and life are concerned" (51). None of the religions of the world excepting the one "described in the vedas" is universal (43). For of the three components of a religion — the *Jñāna, Upāsanā* and *Karma* — the first, when perfect, is alone the true universal element. But "Unfortunately, most of the religions of the world (except the Vedic variety) do not have an ideal knowledge-component" (43). Referring to his own 1990 paper Kaushal writes "In Hinduism the knowledge-component is so perfect that it offers a complete and an ideal description for a naturally accepted life-style at all space and time points in spite of several deviations in recent centuries. Moreover it offers a full-fledged theory (not limited by space and time) for each of the actions of and by human essences of life" (45).

(B) Another important thing which Kaushal has to say in response to the query (3) is that "a theory in science plays the same role as a model in religion. As a result it becomes rather natural to classify various models in science in the same way as the models in religions" — i.e., in terms of the three components of *jñāna, upāsanā* and *karma*. Accordingly models in science are either knowledge-based or methodology (upasana) based or experiment (karma)-based. All these types of models in science in general and physics in particular describe objective reality in one way or the other (47).

(C) The third thing which Kaushal has to say in this paper is that scientists are also idol worshipper or priest of religion (52). "In a particular model, an idol is basically the geometrical representation of the "infinite" into a "finite" form.." "Also, in science, a scientist assumes the "infinite" by a "finite" with some postulates and adopts all sorts of methodology to have communication with different experiment" (51).

A model whether in religion or science is representation of the infinite (or the absolute reality) in the finite. "... Limitations of human faculties (like E [ego], I [intellect], M [mind], SE [sensory and motor apparatus] and B [body]) and also of scientific instrument to understand, to explain or to describe the infinite, normally leads to the process of modelling in both religion and science" (48).

Jñāna based or *Upāsanā* based model arises in science when the finite (representation of the infinite) "is designed at the level of E or I ; "On the other hand, if this "finite" is designed at the level of SE, B or scientific instrument level then this will give rise to K-type models in science and action or practice-dominated models in religion. Further more, while E, SE, and B contribute uniformly

to the models of both religion and science, M dominates the models in religion and I dominates the models in science" (48).

III

Shri Kaushal says too many things. But neither the sense of the individual things he says nor the relation between what different things he says is always clear or convincing. He may very well have something very important to say. But the lack of rigour and clarity in his writing gives just the opposite impression. Not only the paper does not serve the positive purpose of communication if something important Kaushal has to communicate, it on the other hand serves the negative purpose of presenting Hindu philosophy and religion on the one hand and Kaushal's research in science, religion and philosophy on the other in a very poor light.

"...in order to understand the reality described by science the three-world concept has been prevailing for some time in the philosophy of science". In spite of what Kaushal says we are unable to believe that there is any philosopher of science who can manage to speak in the following words. "The world described by the models of physics is the physical world, the world perceived by the human being is the mental world and the world which really exists is the conceptual world" (49). Kaushal further says that these three worlds are basically the world of objective reality, the world of subjective reality and the world of the infinite or absolute reality.

According to Kaushal the model of reality is something less than reality. He says that both the "subjective reality" of religion and the "objective reality" of science "just carry a certain fraction of the infinite" — and this infinite is the absolute reality (49). Kaushal appears to think that it should be our goal to realize the unity of the subjective and objective reality with this infinite and absolute reality. Hindu philosophy just not only emphasizes this but also has something very definite and convincing to say why we are prevented from realizing this and how we can eventually realize it.

Everything in Kaushal's paper is so novel that it is hardly intelligible. In every second sentence he uses certain familiar expression in such a novel way that unless one is provided with a dictionary by Kaushal himself — or by A.R. Verma who in some "private communications" (53) proposed a similar taxonomy of models in science "for the research in science" (47) — it is not possible for any reader to make consistent sense of what the says. When Kaushal does provide such dictionary at different stages of the development of his paper one wonders if there is enough justification for the trouble he takes. Most of the expressions are familiar expressions

with standard senses of their own. Kaushal nowhere puts forward any cogent argument why he wants to change their meaning. And such deviations or changes does not seem to be informed by any urgent need. Lastly Kaushal does not make anything clearer by deviating from the established senses. To be specific, what does he gain by classifying "models in science as Jnana (or knowledge)-based, Upasana (or methodology)-based and Karma (or experiment)-based ?. If he says that this makes it easier to compare models in science with those in religion, the question is why need one admit that there are models in religion also ? In answer, Kaushal will say that both religion and science aim at describing or explaining reality and models are necessary for such description or explanation. But even then one would be left to wonder why does he think so.

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Opinion Communicated

I. "I would like to suggest that a very useful addition would be a section of the journal that would encourage dialogue. This might be a 'Letters' section that specifically asks for commentary on articles already published in the journal, also allowing the authors to respond. I believe that such dialogue would be in the true spirit of philosophy and science."

Mandel Sachs
Department of Physics
State University of New York at Buffalo
USA

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II. "... there are already several successful journals of this type, and it could well be that you should adopt a different view and aim to produce a journal that exploits the special knowledge and understanding of philosophers and scientists in the Indian subcontinent."

Chris Isham
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